704 OSCILLOSCOPE INSTRUCTION MANUAL

DU MONT

ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPE 704 OSCILLOSCOPE INSTRUCTION MANUAL

Serial No. 320

FAIRCHILD

DU MONT LABORATORIES

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

SCIENTIFIC INSTRUMENT DEPARTMENT

750 Bloomfield Avenue, Clifton, New Jersey, U.S.A.

© 1963 Fairchild Camera and Instrument Corp.

Part No. 6704 1961

TABLE OF CONTENTS

Section	Title	Page
1.	**TECHNICAL SUMMARY**	
1-1	Introduction	1-1
1-2	Features	1-1
1-3	List of Recommended Accessories	1-2
1-4	Technical Summary	1-2
2.	**OPERATING INSTRUCTIONS**	
2-1	First Time Operation	2-1
2-2	Adjustment of Vern Bal and Atten Bal Controls	2-1
2-3	Thermal Cutout	2-1
2-4	Precaution Against Screen Burning	2-1
2-5	Illuminated Scale	2-1
2-6	Applying a Signal	2-7
2-7	Use of Probes	2-7
2-8	X and Y Input Selector Switches	2-7
2-9	Obtaining a Display	2-8
2-10	X and Y Cal Adjustment	2-9
2-11	Sweep Triggering	2-9
2-12	Trigger Source Selection	2-9
2-13	Trigger Coupling Selection	2-10
2-14	Trigger Slope Selection	2-10
2-15	Trigger Level Selection	2-10
2-16	Sweep Operational Modes	2-11
2-17	Sweep Expander	2-11
2-18	X-Y Displays and Electronic Shutter	2-12
2-19	Intensity (Z Axis) Modulation	2-13
2-20	Voltage Measurements	2-13
2-21	Time Measurements	2-14
2-22	Rise Time Measurements	2-15
2-23	Phase Shift Measurements	2-16
3.	**CIRCUIT DESCRIPTION**	
3-1	Introduction	3-1
3-2	Vertical Deflection System	3-1
3-3	Horizontal Deflection System	3-3
3-4	Trigger Circuit Description	3-3
3-5	Sweep Circuit	3-5
3-6	Low-Voltage Power Supply	3-7
3-7	CRT Circuit	3-7
4.	**PERFORMANCE ASSURANCE TEST**	
4-1	Maintenance Check to Assure Performance	4-0
4-2	Iinitial Setup of Type 704	4-0
4-3	Checking the Power Supply	4-0
4-4	Checking X and Y Input Selector Switches	4-0
4-5	Checking X and Y Attenuator Switches	4-2
4-6	Checking Sweep Calibration	4-2
5.	**MAINTENANCE AND RECALIBRATION**	
5-1	Introduction	5-1
5-2	Removal and Replacement of Parts	5-1
5-3	Cathode-Ray Tube Replacement	5-1
5-4	Servicing Hints	5-1
5-5	Preventive Maintenance	5-2
5-6	Test Equipment Required for Service Adjustments	5-2
5-7	Adjusting the HV and LV Power Supplies	5-3
5-8	CRT Adjustments	5-3
5-9	X and Y Output Level Adjustments	5-3
5-10	Vernier and Attenuator Balance Adjustments	5-3
5-11	Normalizing X & Y Amplifiers	5-3
5-12	Phase Shift Adjustment	5-4
5-13	X Attenuator Alignment	5-4
5-14	Y Attenuator Alignment	5-4
5-15	X Input Capacitance Adjustment	5-4
5-16	Y Input Capacitance Adjustment	5-5
5-17	Sweep Adjustments	5-5
5-18	230-Volt Operation	5-5
6.	**PARTS LISTS AND SCHEMATICS**	
6A	Electrical Parts List	6-1
	List of Recommended Vendors	6-5
6B	Spare Parts List	6-7

ILLUSTRATIONS

Figure	Title	Page
1-1	Type 704 Oscilloscope	1-1
2-1	Front Panel Facilities, CRT System	2-2
2-2	Front Panel Facilities, Vertical Deflection System	2-3
2-3	Front Panel Facilities, Trigger and Time Base System	2-4
2-4	Front Panel Facilities, Horizontal Deflection System	2-5
2-5	Initial Setup of Type 704 Oscilloscope	2-6
2-6	Illustrating Differential Operation	2-8
2-7	Lissajous Pattern Recorded with and without Controlled Exposure Brightening	2-12
2-8	Peak-to-Peak Voltage Measurements	2-13
2-9	Instantaneous Voltage Measurements with Respect to Ground (or some other reference potential)	2-14
2-10	Elapsed Time Measurement	2-14
2-11	Finding the Frequency	2-14
2-12	Rise Time Measurement	2-15
2-13	Phase Shift Measurement	2-15
3-1	Y Input Circuit, Simplified Functional Block Diagram	3-1
3-2	Y Differential Amplifier Functional Block Diagram	3-2
3-3	X Input Circuit, Simplified Block Diagram	3-3
3-4	X Differential Amplifier, Functional Block Diagram	3-4
3-5	Trigger Circuit, Functional Block Diagram	3-4
3-6	Sweep Generator, Simplified Diagram	3-5
4-1	Initial Setup of Type 704 Oscilloscope	4-1
5-1a	Identification of Replaceable Components	5-6
5-1b.	Identification of Replaceable Components	5-7
5-2a	Identification of Replaceable Components	5-8
5-2b.	Identification of Replaceable Components	5-9
5-3a.	Identification of Replaceable Components	5-10
5-3b	Identification of Replaceable Components	5-11
6-1	Identification of Replaceable Parts	6-0

SECTION 1
TECHNICAL SUMMARY

1-1. INTRODUCTION

The Type 704 Oscilloscope is a measuring instrument designed to be used for almost any general application. The wide bandwidth of this instrument assures that it can be used with many laboratory and field maintenance applications, while dc amplification provides that the lowest frequency portions of signals will be faithfully reproduced.

1-2. FEATURES

- Constructed for universal bench or rack use. A tilt foot assembly for bench use is supplied with each unit
- Provisions for differential or single-ended vertical and horizontal input signals
- Identical frequency response and gain of both X and Y amplifiers extending from dc to 3 db down at 500 Kc at a sensitivity of 0.2 millivolt/cm
- Calibration voltage is provided for each amplifier
- Calibrated linear sweep rates from 5 microseconds/cm to 2 seconds/cm in eighteen steps of 1, 2, and 5 sequence
- Uncalibrated linear sweep, continuously variable in rate from 5 microseconds/cm to 6 seconds/cm. Longest sweep time is 60 seconds full scale.
- Driven automatic, or single (armed) sweep operation with automatic forward trace brightening
- Calibrated sweep may be expanded up to 50 times; uncalibrated expansion up to 1000 times
- Examination on the screen of any portion of X or the expanded sweep signal without distortion
- CRT deflection is driven directly from transistorized amplifiers
- All power supplies and heater voltage for critical tubes are regulated
- Silicon transistors and ac stabilization assure maximum drift stability

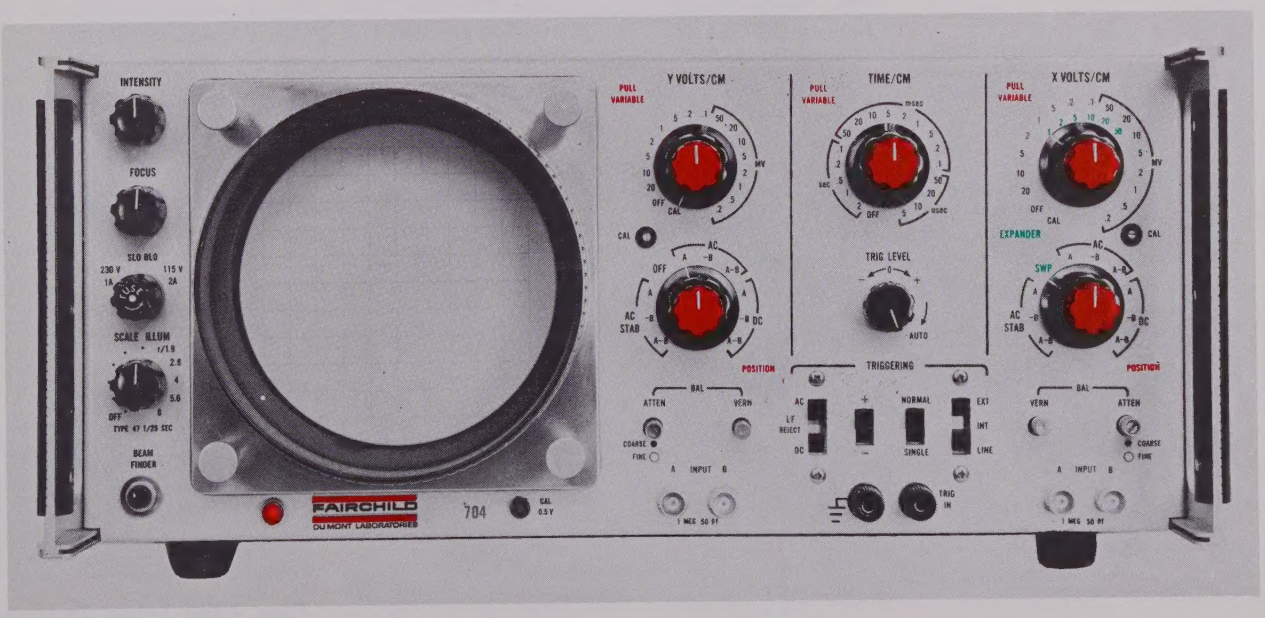


Figure 1-1. Type 704 Oscilloscope

1-3. LIST OF RECOMMENDED ACCESSORIES

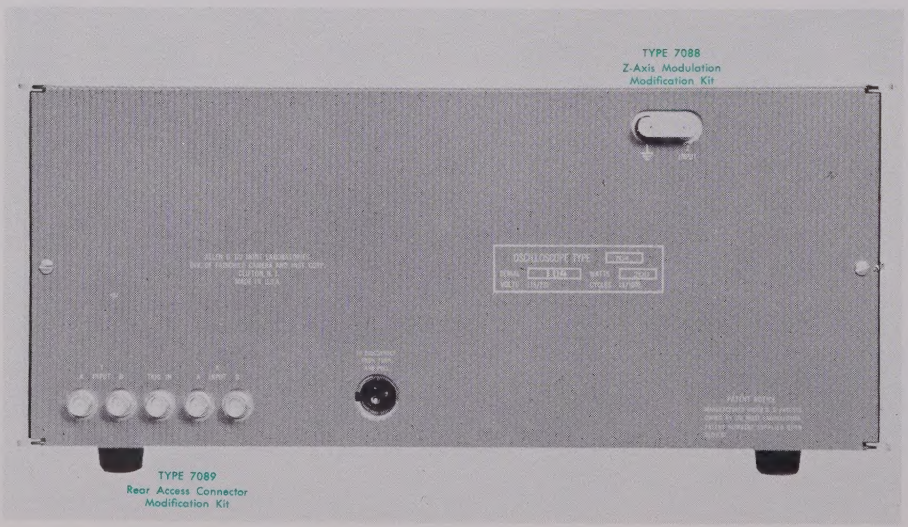
Type or Part Number	Description
	ATTENUATOR PROBES
	(10:1 Passive Probe; terminated in BNC type connector)
4290	10 megohms, 10 pf input; 4-foot cable
4298	10 megohms, 14 pf input; 8-foot cable
4299	10 megohms, 12 pf input; 6-foot cable
	COLOR FILTERS
4800 5861	Amber for P7 screen
4800 5862	Blue for P11 or P7 screen
4800 5863	Green for P1, P2 & P31 screen
4800 6101	Neutral filter, circularly polarized
	KITS
4296A	Operational accessory kit contains:

Qty.	Type	Description
1	276-C	Viewing Hood
2	4285	50-ohm termination
1	4290	Probe
		TERMINAL ADAPTERS
1	4287	Right angle; UG-306A/U
2	7080	UG-1090/U BNC to binding post
1	7081	Adapter Connector, BNC Type UG-274/U
2	7084	UG-636/U C male to BNC female
1	.....	Adapter Connector, BNC female to UHF female UG-255/U

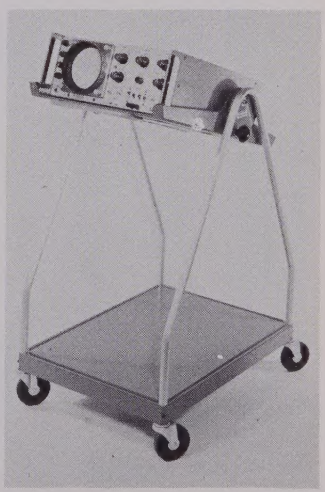
Type or Part Number	Description
7011	Tool kit
7042	Internal no-parallax graticule kit (color filter not required)
7088	Z-axis modulation modification kit
7089	Rear access connector modifiation kit
	RECORDING CAMERAS
450A/453A	Oscilloscope record camera with suitable accessories
	SCOPE TRAVELER & RACK SLIDE ADAPTERS
7030	Scope Traveler
7085	Slides for rack mounting
7086	Rack-mounting ears
	MISCELLANEOUS
276-C	Viewing Hood
7012	Input Capacitance Standardizer
7080	UG-1090/U BNC to binding post
7081	Adapter Connector, BNC Type UG-274/U
7084	UG-636/U C male to BNC female

1-4. TECHNICAL SUMMARY

The electrical and physical characteristics of the Type 704 are listed in Table 1-1 which follows.



Types 7088 and 7089 Optional Accessory Kits (Installed)



Type 7030 Scope Transfer Traveler (Accessory)

TABLE 1-1
TECHNICAL SUMMARY
TYPE 704 OSCILLOSCOPE

CATHODE-RAY TUBE DATA

Type ..... KC2308-P31, tight tolerance, high resolution cathode-ray tube is normally supplied

Optional Phosphors ..... P1 for visual use; P7 phosphor for long persistence low frequency or transient observation; P11 for photographic use; and P2 phosphor for combination visual and photographic use are also available

Over-all Accelerating Potential ..... 2500 volts

Bezel ..... Light-proof bezel provides firm mount for an oscilloscope camera and permits ready interchange of filters and scales

CRT Scale ..... Engraved edge-lit scale having 10 cm by 10 cm graduations and appropriate color filter over face of tube. Scale illumination control varies illumination level from zero to intensity adequate for photographic recording. CRT internal no-parallax graticule is optionally available.

Display Area ..... 10 cm by 10 cm

Beam Finder ..... A spring-loaded push-button switch is provided to facilitate location of beam when it is positioned off screen

Z Axis
(Optional Type 7088 Kit) ..... Negative pulse to grid of CRT blanks trace. 25 volts are required into an impedance of approximately 600K ohms coupled via 3300 pf capacitor to dim trace

VERTICAL-DEFLECTION SYSTEM

BANDWIDTH

Direct Coupled ..... DC to 500 Kc; down 3 db ±1 db at 500 Kc

Capacitively Coupled ..... 2 cycles low frequency cutoff

Rise Time ..... 0.8 microsecond with less than 2% overshoot or preswing

AC STABILIZATION — When the oscilloscope is operating in the AC STAB mode, drift is minimized to less than 1 millivolt/hour

AC STAB LF CUTOFF

Range	Nominal Cutoff Frequency
0.2 mv/cm	4 ~
0.5 mv/cm	2.5 ~
1 mv/cm	2 ~
2 mv/cm	2 ~
5 mv/cm	2 ~
10 mv/cm	2 ~
20 mv/cm	2 ~
50 mv/cm	2 ~
100 mv/cm	2 ~
200 mv/cm	2 ~
500 mv/cm	2 ~
1 v/cm	2 ~
2 v/cm	2 ~
5 v/cm	2 ~
10 v/cm	2 ~
20 v/cm	2 ~

TABLE 1-1. TECHNICAL SUMMARY (Continued)

SENSITIVITY

Calibrated Operation ..... Provided by a frequency-compensated attenuator with steps from 0.2 millivolts/cm to 20 volts/cm, when PULL VARIABLE control is preset to CAL; accurate to within ±3% when set on any one step. An OFF position is included for dc balancing. Differential input on all attenuator ranges.

Uncalibrated Operation ..... Continuously variable from 0.2 millivolts/cm to 50 volts/cm. The PULL VARIABLE control permits 2½ to 1 continuous sensitivity adjustments between the attenuator steps and extends the 20 volts/cm range to 50 volts/cm. The VARIABLE knob is provided with a push-pull switch to facilitate calibration check; the pulled knob indicates uncalibrated vernier gain setting.

INPUT DATA

Input Connectors ..... BNC connectors are provided for selection of one of two individual channel single-ended inputs, or dual use for differential input; choice of ac, dc, or stab coupling

Input Impedance

Single-ended ..... 1 megohm, constant within ±3% at all attenuator settings; nominally 50 pf; constant within ±5% from range to range

Differential Input ..... 2 megohms shunted by less than 40 pf

Input Coupling ..... Direct or through capacitor of 600-volt rating to amplifier

COMMON MODE

Rejection Ratio ..... Nominally 120:1, always better than 100:1 (40 db). Applies to 0.2 mv/cm through 20 mv/cm attenuator ranges only. Attenuator accuracies are additive on all other ranges. Measured at 60 cycles and not controlled at higher frequencies

Maximum Signal ..... Common mode signal must not exceed 6 volts peak-to-peak ac or ±3 volts dc on 0.2 mv/cm to 20 mv/cm ranges; must not exceed 60 volts peak-to-peak on 50 mv/cm to 0.2 v/cm ranges; must not exceed 300 volts peak-to-peak on 0.5 v/cm to 20 v/cm ranges

PHASE SHIFT ..... Vertical and horizontal amplifiers are identical. At maximum gain, the phase shift between the orthogonal systems is adjustable to ±1° at any point from dc to 100 Kc. When adjusted to 0° at 100 Kc, the phase shift differential is ±2° from dc to 150 Kc

HORIZONTAL-DEFLECTION SYSTEM

Same characteristics as the Vertical Deflection System except that the X VOLTS/CM switch also provides for sweep expansion by factors of 1, 2, 5, 10, 20 and 50.

TRIGGERING SYSTEM

TRIG INPUT COUPLING

AC ..... High-pass filter; 80 cycles to low-frequency cutoff

DC ..... Direct coupled to:

(1) preserve very low frequencies;

(2) maintain the initial reference position of the trace with respect to the CRT scale at a given trigger level setting when on internal source; and

(3) avoid trigger point variations due to random repetition rate trigger signals

TABLE 1-1. TECHNICAL SUMMARY (Continued)

LF REJECT	Differentiated trigger input; high-pass filter is provided to reject hum and low-frequency amplitude modulation; low-frequency cut-off nominally 15 Kc. Signals should rise or fall in less than 10 μsec to pass the LF reject filter
SLOPE LEVELING	
Polarity	Selection of positive or negative slopes on Internal, Line, or External triggering is available.
Trigger Level	A range of ±10 volts for External Trigger Input or 1½ times full scale on internal triggering
TRIGGER SENSITIVITIES	
Internal	Signals to 300 Kc will synchronize from ½ centimeter of vertical signal on driven and single sweep position. Less than 4 millimeters are required in the auto triggering position. A choice of trigger polarity (slope) is available
Line	Line frequency synchronization can be selected in either polarity and the triggering point may be shifted with the TRIG LEVEL control
External	0.5 volt peak-to-peak from dc to approximately 300 Kc will synchronize the sweep. 0.75 volt peak-to-peak will synchronize the sweep to 500 Kc
	Trigger leveling, polarity selection, and ac or dc coupling are included. 0.75 volt peak-to-peak will trigger the sweep from dc to over 500 Kc in Driven and Single Sweep positions. Approximately 0.4 volt peak-to-peak is required in Auto Triggering operation.
AUTOMATIC TRIGGERING	Auto triggering is available on internal, external, and line trigger sources. Auto triggering simplifies synchronization and provides a continuous base line at a frequency of approximately 50 cycles. Auto triggering modes permit synchronization of signal frequencies in the range beyond 1 Mc
TIME BASE SYSTEM	
SWEEP RANGE	
Calibrated	5 microseconds/cm to 2 seconds/cm in eighteen steps. Step sequence is 1, 2, and 5. An "off" position is included
Uncalibrated	Continuously variable, uncalibrated between ranges and extends the 2 seconds/cm range to 6 seconds/cm (60 seconds full scale)
Accuracy	Normally within 2% always within 3% (averaged over the centered 8 cm portion of the CRT screen)
Sweep Expansion	The sweep may be expanded about center of screen from 1 to 50 times in 1, 2, and 5 sequence. Extends fastest sweep rate to 0.1 microsecond/cm. Greater expansions are available in uncalibrated mode to 1000 times
Expansion Accuracy	±5% for sweep rates up to 1 microsecond/cm; ±10% at faster sweep rates to 0.1 μsec/cm
Expanded Sweep Positioning	Sufficient to position any full scale portion of the expanded trace on the screen
Single Sweep	An unblanked single-sweep mode is available with reset via a front panel switch
Electronic Shutter	Controlled exposure brightening for multiple X-Y displays through use of triggered sweep. This feature may be switched out by setting the sweep to the "off" position or by using SINGLE sweep mode

TABLE 1-1. TECHNICAL SUMMARY (Continued)

INTERNAL CALIBRATION SYSTEM

VOLTAGE CALIBRATOR

Amplitude ..... 0.5V peak-to-peak calibrator signal available at pin jack on front panel; fast rise and fall time permits adjustment of attenuator probe

Frequency ..... Locked to power-line frequency. This signal may be used to calibrate the time axis wherever the power-line frequency is a controlled standard

Application ..... The same 0.5V calibrator signal is inserted directly into the input stage of the X or Y amplifier via the attenuator switches to aid in standardizing gain. Accuracy nominally 1%, always within 3%

POWER SUPPLY

POWER REQUIREMENTS

Line Voltage ..... From 105 to 125 volts or from 210 to 250 volts at 60-cycle line

Line Frequency ..... Operation from 48 through 450 cycles; line voltage excursion is reduced at extremes of frequency range and where power line distortion exceeds 5%

Power ..... 170 watts average; 200-volt amperes at 115-volt, 60-cycle line

DC Power Supplies ..... All supplies including the critical tube heaters are electronically regulated

PHYSICAL CHARACTERISTICS

NOTE: This oscilloscope is constructed for universal bench or rack use.

BENCH INSTALLATION DIMENSIONS

Height (with feet)	7⅝ inches	(19.3 cm)
Width	16¾ inches	(42.5 cm)
Depth	19½ inches	(49.5 cm)
Weight	32 pounds	(14.5 kg)
Shipping Weight	42 pounds	(19.1 kg)

RACK INSTALLATION DIMENSIONS

Height	$6\frac{31}{32}$ inches	(17.7 cm)
Width	19 inches	(48.2 cm)
Depth (extension behind panel)		
Normal Mounting	17½ inches	(44.5 cm)
Brackets Reversed	16½ inches	(42.0 cm)

NOTE: A minimum of 2" clearance must be maintained when rack-mounting to assure adequate cooling. Do not subject the unit to the hot exhaust air of adjacent equipment.

SECTION 2
OPERATING INSTRUCTIONS

2-1. FIRST TIME OPERATION (Figures 2-1 to 2-5)

To place the instrument in operation, plug the power cord into the proper grounded power source and turn INTENSITY control counterclockwise. Rotate the SCALE ILLUM control clockwise to apply power. Allow approximately 30 minutes for the instrument to warm up. In the instructions which follow, the words in capital letters within the text indicate front-panel controls, connectors, or settings.

Numerous accessory components are available to extend the usefulness of these oscilloscopes. See Section 1 for a complete listing.

The following illustrations are designed to aid the operator in becoming familiar with the oscilloscope.

Figure 2-1. Front-panel Facilities, CRT System
Figure 2-2. Front-panel Facilities, Vertical Deflection System
Figure 2-3. Front-panel Facilities, Trigger and Time Base System
Figure 2-4. Front-panel Facilities, Horizontal Deflection System
Figure 2-5. Initial Setup of Type 704 Oscilloscope

We know that you are anxious to get acquainted with your new instrument. To aid you in this endeavor, you may set up the instrument using the built-in calibrator signal to demonstrate the effects of the various controls on the display. See Figure 2-5.

2-2. ADJUSTMENT OF VERN BAL & ATTEN BAL CONTROLS

When the VERN and ATTEN BAL controls are properly adjusted, there will be no depositioning of the beam when the VOLTS/CM and PULL VARIABLE controls are activated. To adjust, proceed as follows:

1. Set Y VOLTS/CM switch to 20 volts and pull out the inner knob (PULL VARIABLE) and rotate fully clockwise.
2. Set X VOLTS/CM switch to 20 volts and pull out the inner knob (PULL VARIABLE) and rotate fully clockwise.
3. Center the spot with the POSITION controls.

Note: It may be necessary to depress and hold the BEAM FINDER button and adjust the VERN BAL controls to position the spot on the screen.

3. Rotate the Y PULL VARIABLE red knob fully counterclockwise.
5. Adjust the Y VERN BAL control to recenter the dot.
6. Repeat steps 4 and 5 until there is no depositioning of the spot when rocking the Y PULL VARIABLE control back and forth.
7. Repeat steps 4, 5, and 6 except use the X PULL VARIABLE and X VERN BAL controls.
8. Set the FINE Y ATTEN BAL control (outer knurled knob) to center of the range.

Adjust the inner COARSE Y ATTEN BAL control until there is no depositioning of the spot when switching the Y VOLTS/CM switch back and forth from the 20-volt position to the OFF position.

9. Repeat step 8 except use X ATTEN BAL and the X VOLTS/CM switch.
10. Recheck steps 6 and 7 and readjust if necessary.
11. Recheck steps 8 and 9 and readjust if necessary.

Note: The VERN BAL and ATTEN BAL adjustments are interdependent and must be repeated several times for optimum balance adjustment.

2-3. THERMAL CUTOUT

A thermal cutout switch is connected in series with one side of the power line in the rack-mounted version of this instrument. When the interior temperature of the instrument exceeds the safety limit, the thermal cutout switch will trip, removing power from the unit. It will reset itself when the interior temperature drops to a safe value. Possible causes of over-heating are restriction of air circulation or high ambient temperature. Rack installation should be designed with a nominal clearance of 2 inches all around (1½ inches minimum) and hot air must not be circulated through the oscilloscope.

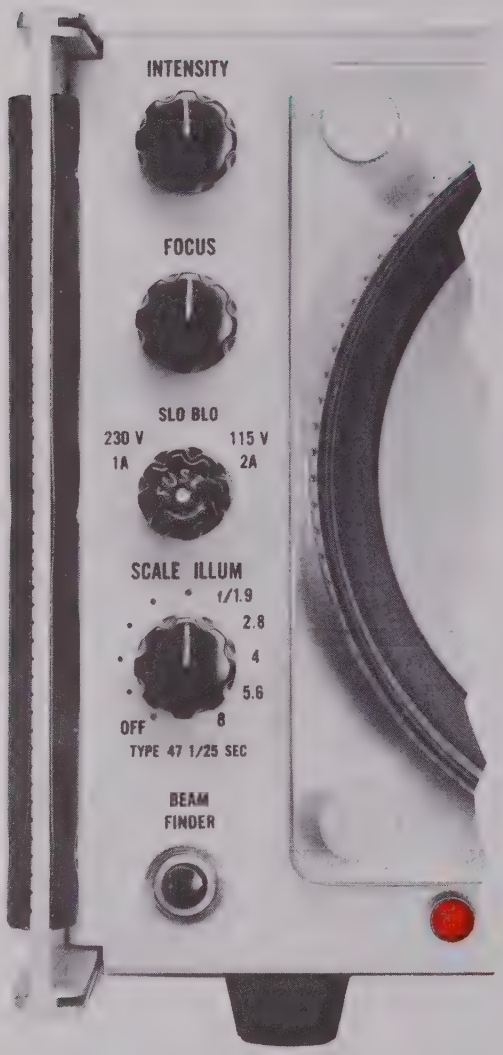
2-4. PRECAUTION AGAINST SCREEN BURNING

A sharply focused spot of high intensity and small area should not be permitted to remain stationary on the screen for any length of time. Under such conditions, the entire beam energy is concentrated over a small area, thus subjecting the screen material to burning and discoloration. This condition is most likely to exist when using the unit for X-Y plotting with the INTENSITY control turned up and no signal inputs. (See paragraph 2-18.)

2-5. ILLUMINATED SCALE

The adjustable scale lighting control labeled SCALE ILLUM may be adjusted to suit the lighting conditions of the room or the f/number on the oscilloscope camera.

The scale is accurately scribed in centimeters. These scale markings and the calibrated fixed attenuator markings and sweep rates, can be used to convert deflection in centimeters into volts and seconds. Vertical and horizontal sensitivities are accurately calibrated in



INTENSITY

Control: varies trace brightness

FOCUS

Control: adjusts trace sharpness

SCALE ILLUM

Control with switch: dimmer control varies scale illumination; attached switch turns power on or off

PILOT LAMP

Illuminated lamp indicates application of primary power

BEAM FINDER

Momentary control switch: reduces amplifier output and scales down display permitting location of beam and centering with X & Y POSITION controls

Figure 2-1. Front Panel Facilities, CRT System

Y VOLTS/CM

Outer knob (black): provides a discrete, calibrated attenuator for Y input signals with amplitude as indicated on the front panel (PULL VARIABLE in). CAL & OFF settings also provided

PULL VARIABLE

Inner knob (red): provides a 1:2½ variable adjustment permitting maximum gain and overlap of the Y VOLTS/CM setting; push-pull switch assures calibrated amplifier setting

Y CAL

Screwdriver control: sets gain of Y amplifier for specific deflection to insure accuracy of vertical amplitude measurements

Y SELECTOR, POSITION

Concentric Controls:

Outer knob (black): selects one of two individual channels for single-ended input or selects Channels A & B for differential Y input, choice of ac or dc coupling. Use AC STAB setting to minimize low-frequency drift

Inner knob (red): positions trace vertically

Y ATTEN & VERN BAL

Controls: when adjusted prevents vertical depositioning of trace when Y VOLTS/CM and PULL VARIABLE controls are activated

CAL 0.5V

Pin jack: provides an internal calibration signal when VOLTS/CM switch is set to CAL; enables calibration check of 10:1 probe when VOLTS/CM switch is set to 10 millivolts

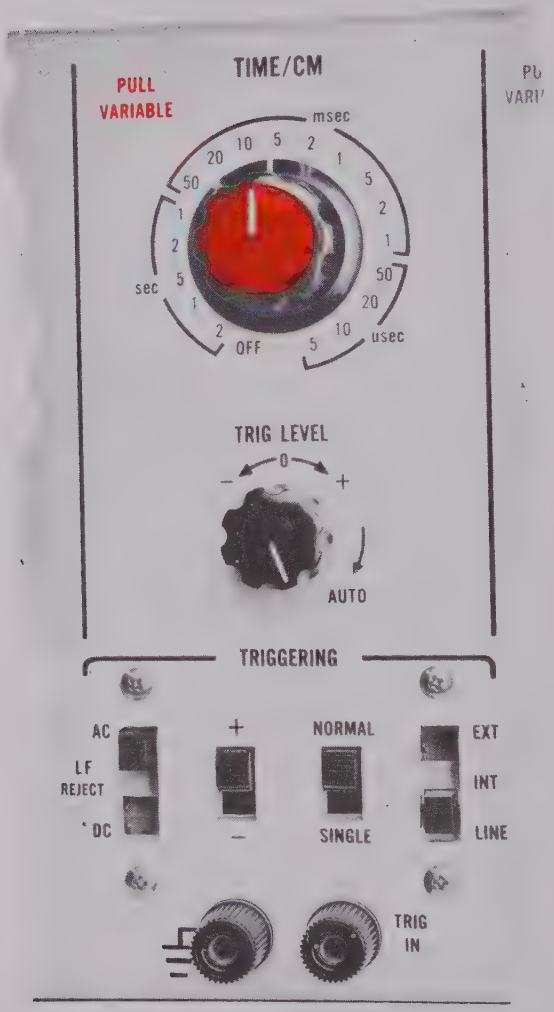
A & B VERTICAL INPUT

BNC connectors: for applying external signals to the vertical deflection amplifier via the Y Input Selector switch

Figure 2-2. Front Panel Facilities, Vertical Deflection System

TIME/CM

Outer knob (black): selects discrete, calibrated sweep rates as indicated on front panel (PULL VARIABLE in).



PULL VARIABLE

Inner knob (red): provides a continuous, uncalibrated range of sweep rates within the limits established by the TIME/CM setting; push-pull switch assures calibrated sweep rates

TRIG LEVEL

Control with switch: selects trigger signal voltage at which the sweep is fired; switch actuation permits AUTOmaic triggering

TRIGGERING

Two, 3-position and two 2-position slide switches: enables trigger selection from internal or external source, direct or capacitive coupling, choice of slope polarities, and normal or single sweep operation as indicated on front panel

TRIG IN

Binding post: for applying external triggering signal through EXT position of Trigger Source slide switch

Figure 2-3. Front Panel Facilities, Trigger and Time Base System

X VOLTS/CM & EXPANDER

Outer knob (black): provides a discrete, calibrated attenuator for X input signals with amplitude as indicated on the front panel (PULL VARIABLE in)

The EXPANDER sector (green) provides discrete expansion of the internal sweep by factors from 1 to 50 when the X Input Selector switch is set to SWP

PULL VARIABLE

Inner knob (red): provides a 1:2½ variable adjustment permitting maximum gain and overlap of the X VOLTS/CM setting; push-pull switch assures calibrated amplifier setting

X CAL

Screwdriver control: sets gain of X amplifier for specific deflection to insure accuracy of horizontal amplitude measurements

X SELECTOR, POSITION

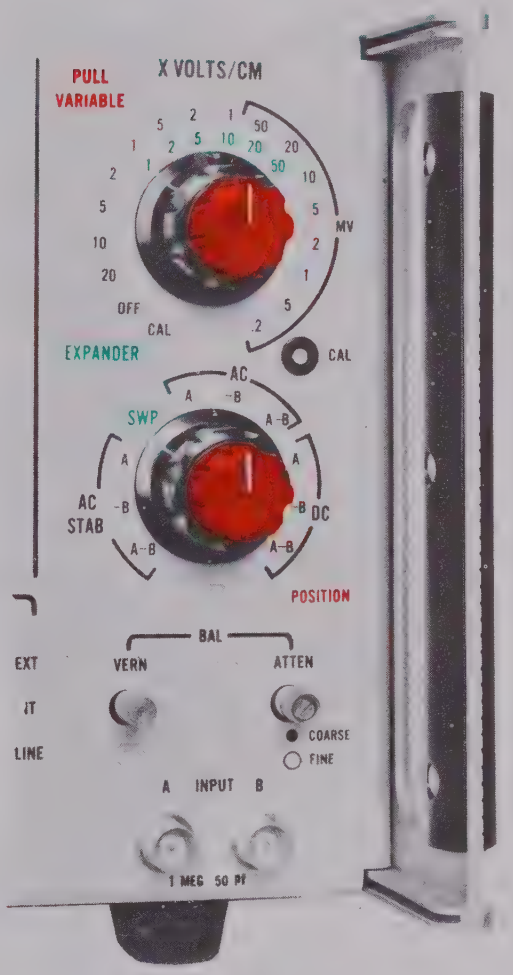
Concentric Controls:

Outer knob (black): selects one of two individual channels for single-ended input, or selects Channels A & B for differential X input; choice of ac or dc coupling. Use AC STAB setting to minimize low-frequency drift

Inner knob (red): positions trace horizontally

X ATTEN & VERN BAL

Controls: when adjusted, prevents horizontal depositioning of trace when X VOLTS/CM and PULL VARIABLE controls are activated



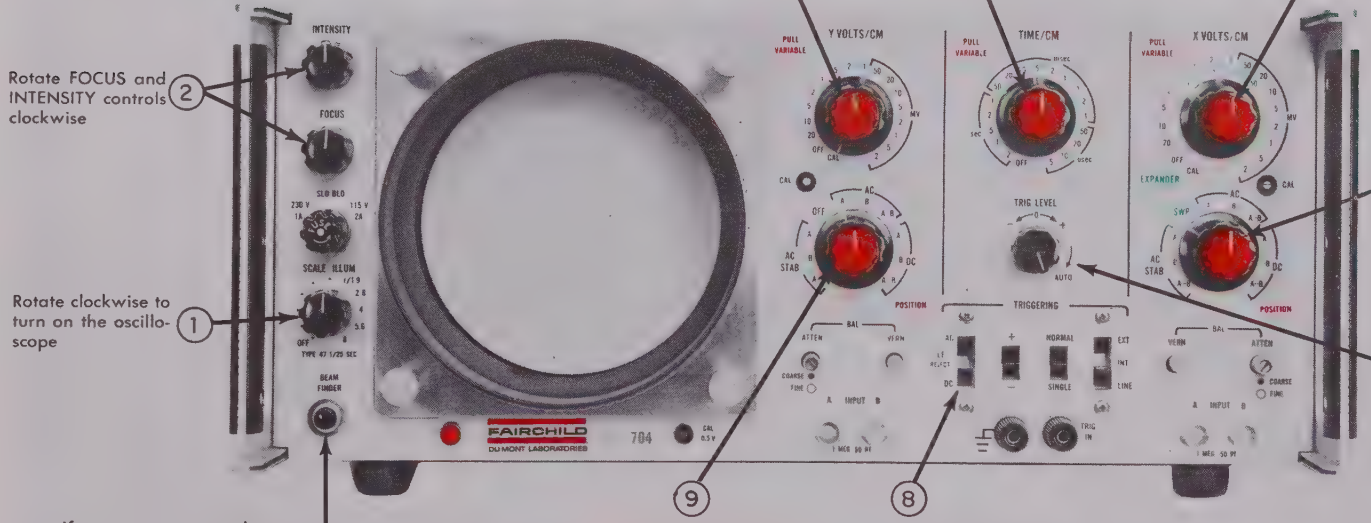
A & B HORIZONTAL INPUT

BNC connectors: for applying external signals to the horizontal deflection amplifier via the X Input Selector switch

Figure 2-4. Front Panel Facilities, Horizontal Deflection System

To obtain the calibrator display, set the controls exactly as shown and perform the numbered steps in sequence.

Use the same procedure when difficulty is experienced when obtaining a display. This will eliminate "cockpit" troubles due to misalignment of controls.


Push in red knob and set outer knob. (Y VOLTS/CM) to CAL
3
Push in red knob and set outer knob (TIME/CM) to 5 mSEC
4
Push in red knob and set outer knob (X VOLTS/CM) to 1 (green)
5
Rotate FOCUS and INTENSITY controls clockwise
2
Rotate clockwise to turn on the oscilloscope
1
Set red knob to center of range and rotate outer knob to SWP (inner knob positions trace horizontally)
6
Rotate clockwise to AUTO until switch is actuated (click is heard)
7
Set red knob to center of range and rotate outer knob to A, Sector AC. (Inner knob positions trace vertically)
9
Set TRIGGERING switches to AC, +, NORMAL, LINE
8
If no trace appears, depress and hold the BEAM FINDER button and readjust POSITION controls (red knobs, see 6 and 9) to center the display
10
Readjust INTENSITY & FOCUS controls (see 2) for a sharp pattern
11
INTENSITY
FOCUS
SCALE ILLUM
BEAM FINDER
Y VOLTS/CM
TIME/CM
X VOLTS/CM
TRIG LEVEL
TRIGGERING
FAIRCHILD
DU MONT LABORATORIES
704

NOTE
X & Y ATTEN BAL & VERN BAL controls must be properly adjusted to obtain an on-screen trace. See paragraph 2-2.

Figure 2-5. Initial Setup of Type 704 Oscilloscope

seconds per centimeter which when multiplied by the number of centimeters of deflection give the voltages and seconds.

An illuminated internal no-parallax graticule is optionally available. No special techniques or equipment are required to photo-record from the Fairchild internal no-parallax graticule.

2-6. APPLYING A SIGNAL

The signal (or signals) to be displayed is applied to either or both input connector on the front panel. To insure proper performance, the signal should be applied through a shielded cable, with the shield connected to the chassis of both the oscilloscope and the signal source.

Accessory Probes are available for use with this oscilloscope and are listed in Section 1 of this manual.

2-7. USE OF PROBES

An attenuator probe lessens both the capacitive and resistive loading caused by the oscilloscope to a minimum value. Simultaneously, while isolating the oscilloscope from the signal source, it reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.

When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under intended observation of a value precisely equal to that of the probe impedance after the probe is removed from the circuit. This substitution will equalize loading and restore the measured characteristics of the circuit under observation.

When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by the attenuator factor marked on the probe.

The Accessory Probes listed in Section 1 of this manual have an attenuation factor of 10 to 1. The maximum voltage that may be applied to these probes is 1200 volts peak-to-peak, 600 volts dc. Voltages in excess of this value (either dc volts or peak ac volts) may cause damage to components inside of the probe housing.

IMPORTANT: Before using the probe, always check its adjustment.

An adjustable capacitor in the probe compensates for variations in input capacitances from one unit to another. To insure accuracy in pulse and transient measurements, check the probe adjustment frequently. To check the probe, proceed as follows:

1. Connect the probe to the Y INPUT A BNC connector and apply the probe tip to the 0.5V CAL pin jack on the front panel.

2. Set Y VOLTS/CM switch to 10 mV and adjust the oscilloscope sweep to display several cycles of the calibrator waveform.

3. Adjust the variable capacitor in the body of the probe for a flat-top trace on the screen.

To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short clean ground point near the probe input connection.

2-8. X AND Y INPUT SELECTOR SWITCHES

a. Switch Selection

Starting from the fully CCW position, the X and Y Input Selector switches provide the following selections:

1. AC STAB coupled differential (balanced) input using INPUT A and INPUT B connectors;

2. AC STAB coupled signal through INPUT B connector, inverted polarity;

3. AC STAB coupled signal through INPUT A connector, normal polarity;

4a. X Selector switch only: SWP position is provided which disconnects the X Input terminals from the X amplifier and applies the internal sweep through the X attenuator to the X amplifier. The EXPANDER sector (green numerals) of the X VOLTS/CM switch may now be employed for magnification of the sweep by factors up to 50 times.

4b. Y Selector switch only: OFF position is provided which disconnects the Y Input terminals and grounds the input of the Y amplifier.

5. AC coupled signal through INPUT A connector, normal polarity;

6. AC coupled signal through INPUT B connector, inverted polarity;

7. AC coupled differential (balanced) input using INPUT A and INPUT B connectors;

8. DC coupled signal through INPUT A connector, normal polarity;

9. DC coupled signal through INPUT B connector, inverted polarity;

10. DC coupled differential (balanced) input using INPUT A and INPUT B connectors.

b. AC Stab Coupling

When the AC STAB sector of the Input Selector switch is in use, low-frequency drift is eliminated in the input section of the amplifier by AC coupling at a point beyond where there is negligible drift. When working in the AC STAB mode, the VERN & ATTEN BAL adjustments should be checked at regular intervals. Optimum stability is reached after thermal equilibrium is reached throughout the oscilloscope (See Table 1-1 for nominal low-frequency cutoff data.)

c. AC or DC Coupling

The AC/DC position of the Input Selector switches permits choice of retaining the dc level of the input signal or blocking the dc component of the input sig-

nal by inserting a capacitor in series with the input. If it is desired to display both the ac and dc components of a signal, set the Input Selector switch to the DC sector. Thus, the position of the display at any instant is a function of the instantaneous signal voltage with respect to ground.

There are times when it is neither necessary nor desirable to display the dc components of the input waveform. A capacitor placed in series with the input connector will exclude the dc component while simultaneously permitting the ac component to be displayed. This is accomplished when the Input Selector switch is set to the AC sector. In this instance, the effect of the dc component is excluded from the display.

d. Differential Input Features (Figures 2-6)

For differential input, set the Input Selector switch to A-B position, and one of the following sectors: AC STAB, AC, or DC.

One of the salient features of the three-terminal balanced-to-ground input circuit is the behavior of the differential amplifier. This circuit makes it possible to reject to a considerable degree any common-mode signal, while at the same time passing and amplifying the differential input signal. Thus, if there is any balanced-to ground pickup of noise on test leads or in the equipment under test, such noise will be reduced materially on passing through the differential amplifier circuit. (See Figure 2-6.)

2-9. OBTAINING A DISPLAY

a. General Instructions

To use the Type 704 Oscilloscope to obtain a display, proceed as follows:

1. Signals to be observed are connected to the oscilloscope through connector INPUT A and/or INPUT B via shielded cable or an Attenuator Probe.

2. Establish a common ground between the oscilloscope chassis and the signal source.

3. The Input Selector switch permits choice of input connector, polarity, and capacitive or direct coupling of the signal to the compensated attenuator as discussed earlier.

4. Adjust the appropriate Time Base controls to obtain a stable display of the pattern. Use of the Auto trigger mode may be desirable in setting up the display.

5. Set the VOLTS/CM switches and POSITION controls such that the size and position of the display

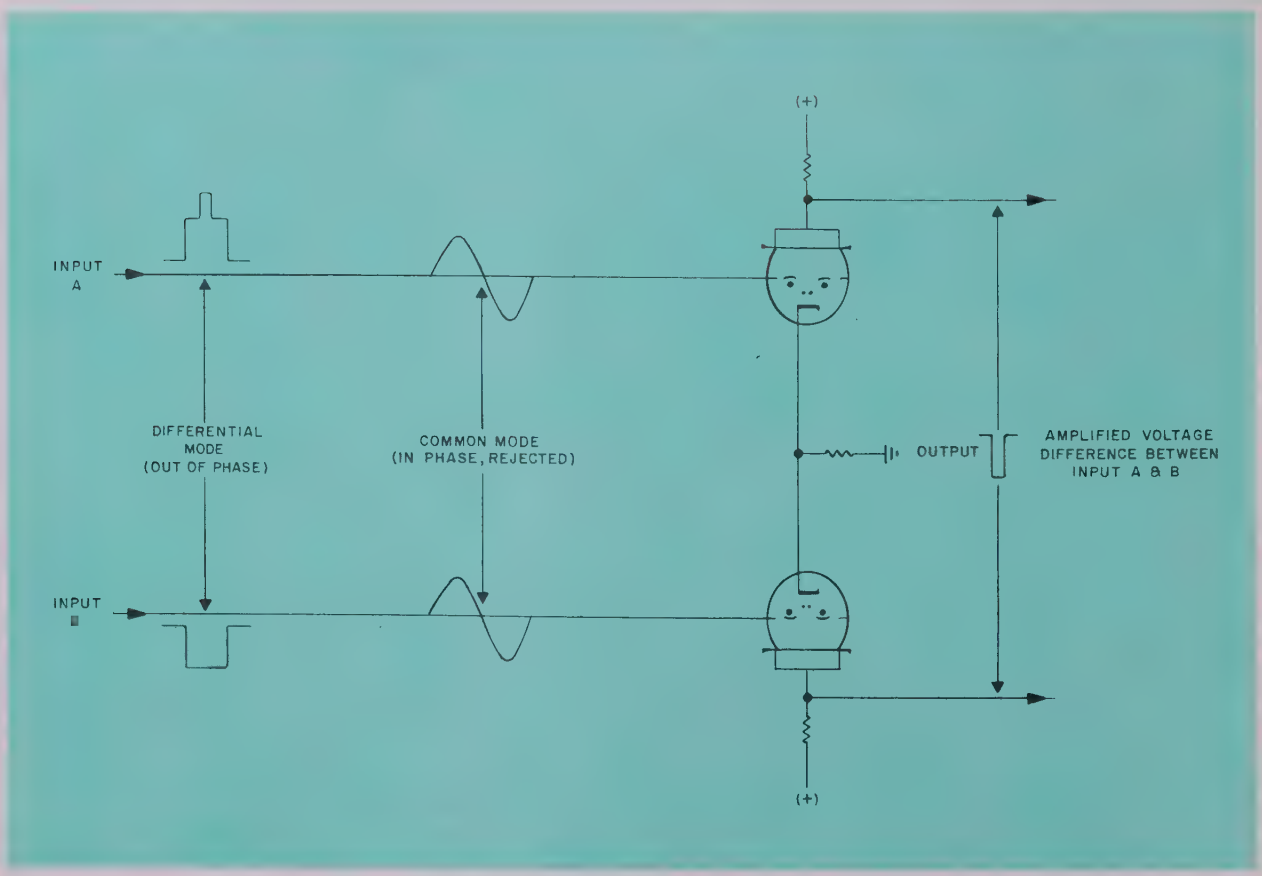


Figure 2-6. Illustrating Differential Operation

is as desired on the screen. If necessary, use the BEAM FINDER push button to speedily locate the display.

b. Signal-Coupling Hints

In addition to the preceding 5 steps, observe the following precautions when applying signals to the oscilloscope:

1. Avoid errors in readings due to stray coupling between circuits, particularly in the signal lead. As a rule, do not use long unshielded leads for applying signals to the oscilloscope. This fact holds for the audio-frequency spectrum, except possibly when making measurements on low impedance circuits at very low frequencies. Coaxial or shielded input cables are recommended for most applications.

2. In broadband applications, it may be necessary to terminate a coaxial cable with a resistance equal to its characteristic impedance. This is done to prevent standing waves or ringing (high-frequency damped oscillations).

3. To avoid erroneous results, the operator should simulate the actual operating conditions of the equipment being tested. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

4. Consider the effect of loading upon the signal source due to the input impedance of the oscilloscope. The input impedance can be represented by a resistance shunted by a capacitance. The effective value of this impedance is indicated in Table 1-1 of this manual. However, the operator should be aware that even with a few feet of cable in the input circuit, the loading capacitance on the circuit under investigation might be greater than 100 pf (μμf).

5. There are cases when connecting the input of the oscilloscope to a signal source, the effect of loading the source is not negligible. To minimize this loading and therefore obtain a valid measurement, a probe may be used in the manner described in the paragraph entitled "Use of Probes."

6. Care must be exercised when applying a fast rise. high-frequency signal to the input connector. It will be necessary to match and properly terminate the coaxial cable applying the signal to the oscilloscope.

7. As the length of the cable is increased, the necessity for proper termination becomes very important. This termination is generally inserted at the oscilloscope end of the cable, although many signal sources may require an additional termination at the other end of the cable.

c. Hints for Rack-Mounting Systems

For rack-mounting systems, observe the following precautions if long shielded cables are used.

1. It may be desirable to ground long shielded leads only at one end to avoid circulation currents. Even micro-amperes of extraneous currents in the shield braid will cause unwanted signal distortions.

2. Use cable with insulation over the shield braid so that the cable does not accidentally touch ground.

3. Use off-ground insulated bulkhead feed-thru connectors where applicable.

4. Do not pass cables near strong ac magnetic fields.

5. Long shielded input cables may also induce parasatic oscillations. It is suggested that a 100-ohm to 1000-ohm ½-watt resistor be connected in series with the center conductor near or at the oscilloscope input terminals.

6. Use a resistance at least twice that required to just stop the parasitic oscillations. Too large a value may reduce the bandwidth of the system.

2-10. X AND Y CAL ADJUSTMENT

To properly normalize the gain of the instrument, proceed as follows:

1. Set up the oscilloscope as indicated in Figure 2-5 except that the X VOLTS/CM switch is set to CAL and the X Input Selector switch is set to any position except SWP.

2. Adjust the Y CAL front-panel screwdriver control for precisely 5 centimeters of vertical deflection.

3. Adjust the X CAL front-panel screwdriver control for precisely 5 centimeters of horizontal deflection.

2-11. SWEEP TRIGGERING

To obtain a stable display, the sweep must consistently start at the same point of a repetitive input waveform. If the sweep is not synchronized to the input waveform, the displayed pattern will be traced out at a different point on the screen each time the sweep runs. This will either cause the waveform to drift across the screen or to be unintelligible. The sweep therefore must be triggered by the input signal, or by some signal which bears a fixed time relationship to the input signal. For present purposes, the starting of each horizontal wave across the screen may be called "triggering the sweep." The following instructions tell you how to select and use the proper triggering signal for various applications.

2-12. TRIGGER SOURCE SELECTION

a. Internal

For most applications, the sweep may be triggered by the Y input signal. The only requirement is that the signal amplitude be sufficient to trigger the sweep. To obtain triggering of the sweep from the input signal, set the Trigger Source switch to INT. Internal triggering is convenient since no external triggering connections are required. Satisfactory results are obtained in most applications.

b. External

Sometimes it is advantageous to trigger the sweep with an external signal. External triggering is especially useful where signals are going to be sampled from several different places within an instrument. With external triggering, the triggering signal usually remains constant in amplitude and shape. Thus, it is possible to observe the shaping and amplification of a

signal in an external circuit without resetting the oscilloscope triggering controls for each observation. Also, time and phase relationships between the waveforms at different points in the circuit can be seen. For example, if the external triggering signal is derived from the waveform at the input to a circuit, the time relationship and phase of the waveforms at each point in the circuit are compared to the input signal by the displayed waveform.

When a stable, external triggering signal is available, it is possible to observe and accurately measure jitter of the displayed waveform with respect to the trigger input signal. This is not possible when the sweep is triggered internally. Internal triggering will not permit base line to show on screen prior to the rise of the signal being observed. A trigger preceding the signal may be used to externally trigger the oscilloscope to display the entire signal.

To obtain a stable display, the external triggering signal must have an amplitude of at least 0.5 volt, peak-to-peak, and bear a fixed time relationship to the displayed signal. To use an external signal for triggering the sweep, connect the signal to the TRIG IN connector and set the Trigger Source switch to EXT.

c. Line

If the pattern on display bears a fixed time relationship to the power-line frequency, the sweep may be triggered by this signal. To accomplish this, set the Trigger Source switch to LINE.

2-13. TRIGGER COUPLING SELECTION

a. AC Coupling

Selection of the AC triggering mode is accomplished by setting the Trigger Coupling switch to AC. This mode is provided with a high-pass filter that has a low-frequency cutoff nominally at 80 cycles. This feature prevents erratic triggering when positioning the pattern vertically while using internal triggering. In the AC mode, triggering is unaffected by the dc components of the triggering signal or by the vertical positioning of the trace. The triggering level can be selected to provide the desired dsplay via use of the TRIG LEVEL control.

When using the AC mode, the Trigger Coupling switch is set to AC. The trace always starts at the same point on the *Waveform* for a given TRIG LEVEL control setting regardless of the vertical positioning.

b. DC Coupling

The DC mode is especially useful for viewing waveforms which change very slowly and which are therefore discriminated against by the low-frequency cutoff of the AC position (80 cps). Because of the coupling network time constant in the AC mode, signals having random repetition rates are sometimes viewed more stably in the DC mode.

This mode permits excellent triggering on all types of waveforms and is most useful in the following applications:

1. For preserving very low frequencies;
2. For maintaining the initial reference position of the trace with respect to the CRT scale at a given TRIG LEVEL control setting when on Internal source; and
3. For avoiding trigger point variations due to random repetition rate triggering signals.

When using the DC mode, the Trigger Coupling switch is set to DC. The trace always starts at the same point on the *Scale* for a given setting of the TRIG LEVEL control regardless of the vertical positioning.

c. LF Reject Coupling

The LF REJECT mode is a special high-frequency form of the AC mode and is used to reject low-frequency components in the triggering signal. Use AC triggering unless low-frequency rejection is required. Triggering signals with frequency components below 15 Kc, for example the calibrator signal, will not initiate the sweep circuits when the LF REJECT mode is used. To insure stability, the triggering signal should rise in less than 10 μsec.

Occasionally it is required to obtain stable triggering from a complex high-frequency waveform that contains undesirable low-frequency noise or line-frequency components. In such cases, the additional noise and line pickup may make it difficult to obtain a stable display. If this occurs, select the LF REJECT triggering mode, thereby eliminating the effects of these undesired components. The low-frequency components are blocked from the triggering circuit while the high-frequency triggering waveform is passed to produce the stable triggering that is required. In all other respects, the LF REJECT triggering mode is identical to the AC mode.

2-14. TRIGGER SLOPE SELECTION

When the Trigger Slope switch is set to +, the sweep is triggered on the rising or positive slope of the excitation signal. When the Trigger Slope switch is set to —, the sweep is triggered on the falling or negative slope of the excitation signal. In general, the triggering slope is not important in many applications since triggering on either slope will provide an appropriate display.

2-15. TRIGGER LEVEL SELECTION

The TRIG LEVEL control permits selection of a specific voltage which the triggering signal must exceed before the sweep fires. When the Trigger Slope switch is set to the + position, adjustment of the TRIG LEVEL control makes it possible to trigger the sweep consistently on the positive slope of the excitation signal. Conversely, with the Trigger Slope switch set to the — position, adjustment of the TRIG LEVEL control makes it possible to trigger the sweep consistently on the negative slope of the excitation signal. See Table 1-1 for trigger level ranges.

2-16. SWEEP OPERATIONAL MODES

a. Introduction

When the Trigger Mode switch is set to NORMAL, the oscilloscope may be set up for triggered or automatic sweep. In the SINGLE mode, the time base moves but one stroke until reset.

b. Automatic Sweep

In some applications, it is desirable to have the sweep free-running, whether synchronized or not. When using the AUTO mode, a horizontal reference trace will appear on the screen even in the absence of an input signal. This AUTOmatic mode is very useful while testing equipment since a reference trace will always be visible regardless of whether a signal is applied to the oscilloscope or not.

The AUTO mode simplifies synchronization of signals or periodic waveforms having repetition rates greater than 50 cycles.

To obtain AUTOmatic sweep operation, set the TRIG LEVEL control fully clockwise to AUTO (switch is actuated) and the Trigger Mode switch to NORMAL.

c. Triggered Sweep

A stable pattern for practically all types of signals can be obtained by using triggered sweep. Its use is mandatory for viewing random or non-periodic signals having low repetition rates. Use of the triggered sweep mode of operation in the majority of applications is the preferred condition under which optimum triggering performance can be expected of this instrument.

When the oscilloscope is set for triggered sweep, the spot will be visible only during forward sweep time. The INTENSITY control must be properly adjusted to make the sweep visible. For triggered sweep operation, proceed as follows:

1. Apply the desired signal to INPUT A and set front-panel controls as previously indicated in Figure 2-5.
2. Adjust Y PULL VARIABLE control in conjunction with Y VOLTS/CM switch to obtain a vertical deflection of approximately 5 centimeters.
3. Adjust TRIG LEVEL control to initiate the sweep and the POSITION controls to center the display.
4. Rotate the TIME/CM and PULL VARIABLE controls to obtain the desired display. Readjust the TRIG LEVEL control if necessary.
5. Adjust INTENSITY and FOCUS controls to obtain a sharp trace of suitable brightness.
6. If there is any multiple triggering of the sweep, the TRIG LEVEL control may be adjusted to select the signal levels which will best actuate the trigger circuit. Thus, undesirable signals of lesser amplitude will be rejected by the trigger channel.
7. Set Trigger Coupling switch to LF REJECT to obtain a more stable display when using high-frequency triggering signals.

d. Single-Sweep Operation

Single-sweep operation infers that the time base moves but one stroke until reset. Using a repetitive sweep to view a varying waveform would result in an overlapped and unintelligible display caused by many cycles of the single trace being superimposed on one another. However, when it is desired to view a single display of an input signal which continually varies in amplitude, shape, or time, the Trigger Mode switch should be set to SINGLE for single-sweep presentation. Thus, by commanding but one stroke of the sweep at a time, the SINGLE position eliminates the overlapping caused by the multiple traces and enables the display to be viewed and/or recorded clearly.

A single trace will sweep across the screen each time the sweep is triggered and at the end of its travel, the beam will rest off screen. To rearm the sweep, set the Trigger Mode switch from SINGLE to NORMAL and back to SINGLE position. The sweep is now armed and ready to fire on the next trigger.

Note: Do not use AUTOmatic triggering or have continuous input of triggers since single sweep will not reset or function properly.

For manual single-shot operation, proceed as follows:

1. Set Trigger Mode switch to NORMAL and Trigger Source switch to INT.
2. Adjust TRIG LEVEL control until sweep just disappears.
3. Set Trigger Mode switch to SINGLE.
4. Flip Trigger Polarity switch up and down; sweep will fire once. (Rocking the TRIG LEVEL control will also cause the sweep to fire just once.)
5. Reset Trigger Mode switch to SINGLE.
6. Repeat steps 4 and 5 for controlled manual single-shot operation.

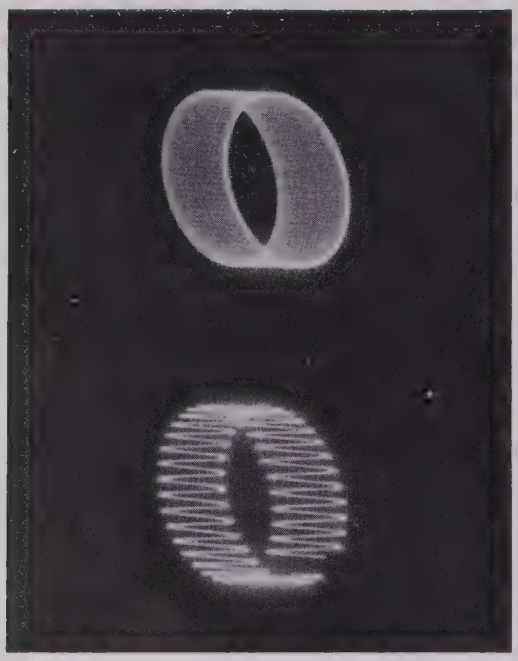
2-17. SWEEP EXPANDER

When the X Input Selector switch is set to SWP, the sweep may be expanded about the center of the screen from 1 to 50 times. The EXPANDER sector (green) of the X VOLTS/CM switch provides horizontal magnification of the internal sweep by factors of 1, 2, 5, 10, 20, and 50. Thus, the fastest sweep rate is extended to 0.1 microsecond/cm. Any portion of the expanded display may be observed by adjusting the POSITION control.

When the instrument is set up for sweep expansion, the sweep rate indicated by the setting of the TIME/CM control must be divided by the expander factor (green numerals of X VOLTS/CM sector) to obtain the actual time required for the spot to move one centimeter. The expanded sweep rate may be expressed as follows:

$$\text{Expander Sweep Time/Cm} = \frac{\text{TIME/CM setting}}{\text{EXPANDER setting}}$$

For example, if the TIME/CM control is set to 5



Upper Pattern: Blurred because varying phase causes drift.

Lower Pattern: Same pattern photographed using electronic exposure brightening.

Figure 2-7. Lissajous Pattern Recorded With and Without Controlled Exposure Brightening

mSEC, and the EXPANDER switch is set to 5, the actual time per centimeter is 5 milliseconds, divided by 5, or 1 millisecond per centimeter.

Or using the formula:

$$1 \text{ msec/cm} = \frac{5 \text{ msec/cm}}{5}$$

2-18. X-Y DISPLAYS AND ELECTRONIC SHUTTER

a. Introduction

When desiring to view one voltage plotted against another (not the internal time base), simply connect the signals to the X and Y input terminals and adjust the oscilloscope controls to obtain an appropriate display on the cathode-ray tube screen. It will be necessary to set the TIME/CM switch to OFF to obtain "steady" intensity. Note that screen damage can result from too intense a beam resting at one point on the screen.

X-Y plots obtained from transducers on rotating machinery, or other sources supplying a family of curves, may be difficult to interpret. The TIME/CM switch should then be used as an "electronic shutter" timing selector which will brighten the display for a period of nominally 10.5 times the sweep rate indicated.

The starting point of the illuminated or "strobed" section of the X-Y display may be adjusted with the TRIG LEVEL control. AC or DC coupled triggering from Y Channel internal, line frequency, or an external source related to the device under test, may be selected with the TRIGGERING switches.

b. Photo-Recording Applications

When the oscilloscope is used to record X-Y displays (without use of the internal time base), the saw generator remains inoperative. If it is triggered from an external source, a normal unblanking gate pulse will be produced. To use this unblanking gate pulse for controlling a photographic exposure (an electronic shutter) proceed as follows:

1. Set the sweep range and vernier controls equal to the desired exposure time.
2. Set Trigger Mode switch to SINGLE.
3. Open the camera shutter on "Bulb" or "Time" and apply the sweep trigger pulse or fire the sweep manually as indicated in a previous paragraph entitled "Single-Sweep Operation."
4. Close the camera shutter.

Figure 2-7 shows a drifting Lissajous pattern of two sine waves having slightly different frequencies. The upper pattern has the CRT beam on continuously while the lower pattern has controlled exposure brightening.

This is an extremely useful technique for recording the output of one transducer versus another, particularly when the phenomenon is non-cyclical. For example, the strain at one point in a mechanical system may be plotted against the velocity, acceleration, or displacement of some member of the prime mover of the system. Wherever the phase of the Y signal is changing relative to the phase of the X signal, this electronically controlled exposure technique is useful.

The start of the exposure can sometimes be controlled by one of the two signals being displayed. For example, the sweep controls can be set so that when the Y signal reaches a set amplitude, the unblanking pulse will occur. Or, one may wish to start the exposure when the X or Y signal reaches its maximum rate of change. In this case the signal can be differentiated and the differentiated signal used to initiate the sweep trigger (through the external input circuit).

Finally, the intensity modulation input of the oscilloscope (Z input) can also be used for controlled exposure brightening (or blanking) of varying or drifting patterns. In this case the exposure control pulse must be taken from an external source, such as a pulse generator.

In using any form of electronically controlled blanking or trace brightening, it should be remembered that the camera mechanical shutter must be fully opened before triggering the sweep on the external pulse to the Z-axis of the CRT. The most common method of taking a photograph with electronic trace brightening is to use "Bulb" or "Time" exposure as previously mentioned.

If the oscilloscope camera shutter has "synchro" con-

tacts, these contacts may be used to initiate the trace brightening, or to arm the oscilloscope sweep circuit. Thus, one may set the camera shutter to some "instantaneous" value from 1 second to 1/100 second and use the shutter contacts to initiate the actual electronically controlled exposure.

Complete instructions and applications for rearming the oscilloscope sweep from the synchro shutter contacts will be found in the appropriate Fairchild Camera Instruction Manual.

2-19. INTENSITY (Z AXIS) MODULATION)

The Type 7088 Z Axis Modulation Kit is available as an accessory for intensity modulation of the trace. Installation instructions are furnished with each kit.

Negative pulses to the grid of the cathode-ray tube will blank the trace. Pulse amplitude of more than 25 volts is required into an impedance of approximately 600K ohms coupled via a 3300 picofarad capacitor to dim the trace.

2-20. VOLTAGE MEASUREMENTS

> **NOTE**
>
> When making voltage measurements, make sure there is a common ground between the oscilloscope and the signal source.

a. General

This oscilloscope may be used to measure the voltage of the input signal by using the calibrated Y VOLTS/CM setting and observing the height of the display on the screen in centimeters.

When making voltage measurements, the operator should try to set up the instrument for full scale vertical deflection to insure maximum accuracy. Also, it is important to remember that the width of the trace may be an appreciable part of the over-all measurement. This is particularly true when you are measuring signals of small amplitude or when stray signal pickup has broadened the trace. The operator should consistently make all measurements from one side of the trace. If the top side of the trace is used for one reading, it should be used for all succeeding readings.

b. How to Measure Peak-to-Peak Voltages Using the CRT Scale

The procedure employed for all voltage measurements is basically the same. The PULL VARIABLE control must be set to CAL (pushed in). The specific examples that follow are intended to show the general procedure. These examples may be adapted to fit any particular application.

To measure the ac component of the signal on display, set the Y Input Selector switch to the AC sector. In this position, only the ac components of the input signal are displayed on the screen. However, when the ac component of the input is of very low frequency (under 10 cps), set the Y Input Selector switch to the DC sector to prevent errors. To make measurements, proceed as follows:

1. Using the calibrated scale, measure the vertical deflection in centimeters from the positive peak to the negative peak of the waveform. See Figure 2-8.
2. Multiply the vertical dimension obtained in Step 1 by the Y VOLTS/CM control setting to obtain the indicated voltage.
3. Multiply the indicated voltage obtained in Step 2 by the attenuation factor of the probe, if one is used, to obtain the actual peak-to-peak voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the peaks of the waveform measures 4 centimeters. Now, the vertical dimension of 4 centimeters is multiplied by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation ratio of the probe. This gives 4 volts as the peak-to-peak voltage of the display waveform.

NOTE: Always make sure that the PULL VARIABLE control is pushed in when making measurements.

c. How to Measure Instantaneous Voltage with Respect to Ground (or Some Other Reference Potential) Using the CRT Scale

The technique used for measuring instantaneous voltages with respect to a reference point, is virtually the same as that described for peak-to-peak voltage measurements. The difference is that now a reference point must be established on the screen of the oscillo-

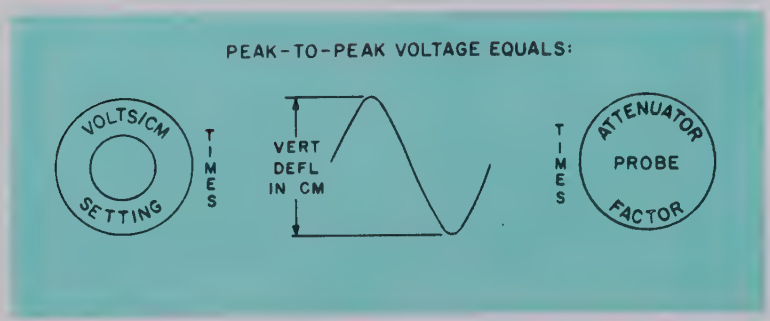


Figure 2-8. Peak-to-Peak Voltage Measurements

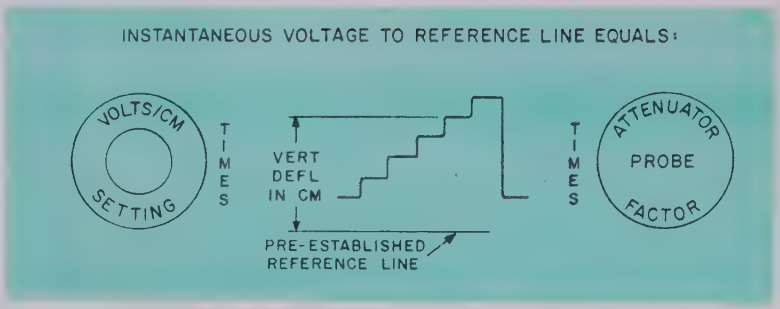


Figure 2-9. Instantaneous Voltage Measurement With Respect to Ground (or Some Other Reference Potential)

scope. Since voltage measurements with respect to ground are the most common, the procedure which follows, establishes ground as the reference point. The same general technique may be used for instantaneous measurements with respect to any other potential, just so long as that potential is employed to establish the reference point.

To make measurements, proceed as follows:

1. Set the Input Selector switch to the DC sector.
2. Adjust the appropriate controls to obtain a reference trace.
3. To establish the reference point, touch the probe tip to the ground terminal on the oscilloscope (or to the desired source potential, if a point other than ground is used). Vertically position the trace to a convenient point on the screen. This point should be chosen so that it lies on one of the major horizontal scale divisions. The chosen horizontal scale line, which is now coincident with the trace, is the reference line from which all voltage measurements are to be made.
4. Disconnect the probe tip from ground and connect it to the signal source without disturbing the POSITION control.
5. Adjust the oscilloscope controls for a suitable and stable display.
6. Using the calibrated scale, measure the number of graticule divisions from the desired point on the waveform to the pre-established reference line set up in Step 3. See Figure 2-9.
7. Multiply the vertical dimensions obtained in Step 6 by the Y VOLTS/CM control setting to obtain the indicated voltage. Make sure that the PULL VARIABLE knob is pushed in.
8. Multiply the indicated voltage obtained in Step 7 by the attenuation factor of the probe used to obtain the actual instantaneous voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the desired point on the waveform to the pre-established reference line is 4 centimeters. Now, multiply this vertical deflection of 4 centimeters by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation factor of the probe. This shows the instantaneous voltage with respect to ground to be 4 volts. Since the voltage point is above the reference line, the indicated polarity is positive.

2-21. TIME MEASUREMENTS

a. How to Make Elapsed Time Measurements Using the CRT Scale

Any horizontal distance on the screen of the oscilloscope can be used to represent a precise interval of time when the time-base circuits are set up for calibrated sweep (PULL VARIABLE control "in"). Use of this feature permits you to accurately measure the elapsed time between the desired point of interest on the display. To measure the time interval, proceed as follows:

1. Using the calibrated scale, measure the horizontal distance in centimeters between that portion of the display whose time interval you wish to find.

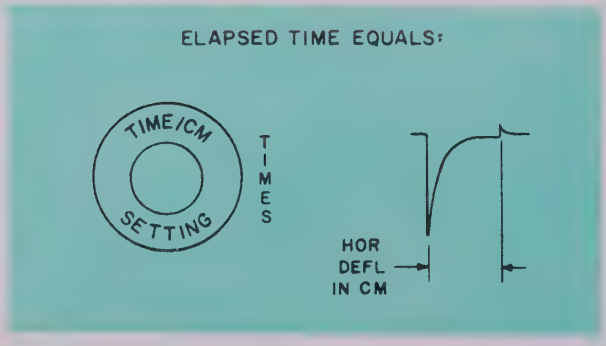


Figure 2-10. Elapsed Time Measurement

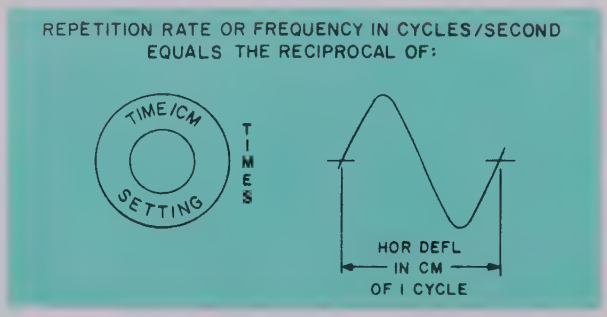


Figure 2-11. Finding the Frequency

2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting to obtain the time interval. See Figure 2-10.

b. How to Find Repetition Rate or Frequency Using the CRT Scale

The repetition rate or frequency for periodic signals can be expressed as the number of cycles or pulses per unit of time. To use the oscilloscope for measuring the repetition rate or frequency of periodic signals, proceed as follows:

1. Using the calibrated scale, measure the horizontal distance in centimeters occupied by one cycle of the display under observation.

2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting.

3. Take the reciprocal of the product obtained in Step 2 (that is, divide it into one). The resulting quotient is the desired frequency or repetition rate in cycles per second. Figure 2-11.

$$\text{Cycles/second} = \frac{1}{\text{Time (seconds)}}$$

2-22. RISE-TIME MEASUREMENTS

Application of signals from an external time calibrator will facilitate pulse rise-time measurements. When making such measurements, the one factor which must be borne in mind for most accurate quantitative results is the pulse response characteristic of the vertical amplifier. This characteristic is related to the observed pulse rise time and the actual pulse rise time in the following manner:

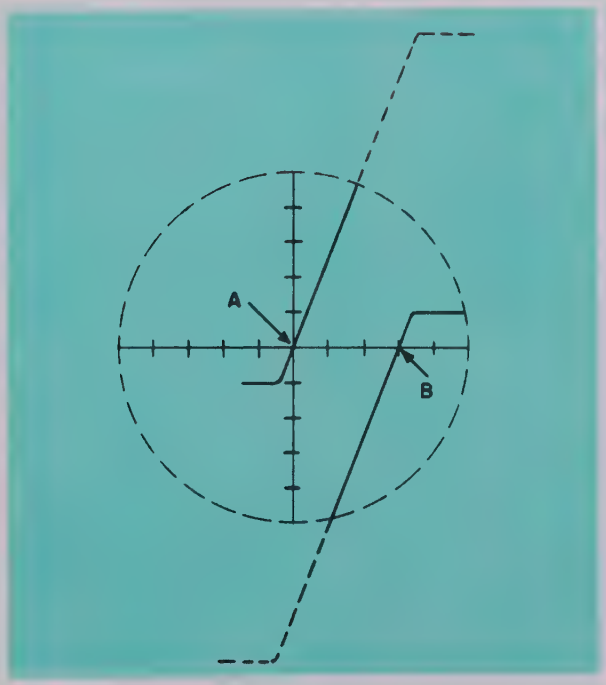


Figure 2-12. Rise Time Measurement

$$t_p = \sqrt{(t_o)^2 - (t_a)^2}$$

Where: t_p = actual pulse rise time in microseconds
t_o = observed rise time of pulse displayed on oscilloscope in microseconds
t_a = amplifier rise time in microseconds (Type 704 $Y_{ta} \sim 0.8$ μsec)

Once the amplifier rise time is known (see Table 1-1), the rise time of any pulse may be calculated.

To make rise-time measurements, proceed as follows:

1. Adjust pattern for full scale (10 cm) of vertical deflection.

2. Using the X and Y POSITION controls, adjust the display vertically so that the start of the waveform rests 1 centimeter below the scale horizontal center line and the rising portion of the waveform intersects the zero point on the scale (labeled A in Figure 2-12). Observe that the top of the waveform is off screen. Be careful not to accidentally change the setting of the X POSITION control.

3. With the Y POSITION control, move the waveform down until the top portion of the waveform rests 1 centimeter above the horizontal center line.

4. Note where the rising portion of the waveform intersects the X axis (labeled B in Figure 2-12).

5. Measure the distance between points A and B; multiply this reading by the TIME/CM switch setting to obtain rise time.

6. For example, if the distance between points A and B is 3 centimeters and the TIME/CM switch is set to 5 μs, the rise time would be 15 μs.

7. Rise-time measurements made in this manner eliminate errors which would result from improper deflection plate alignment and incorrect interpolation.

8. Rise time of the amplifier may be checked by applying a pulse with an input rise 5 or more times faster than the amplifier.

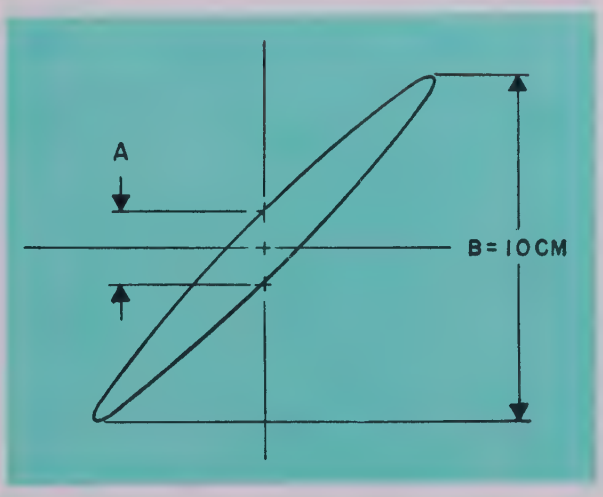


Figure 2-13. Phase Shift Measurement

2-23. PHASE SHIFT MEASUREMENTS

Phase shift measurements are usually made when the frequencies of the two input ac signals are equal. Hence, Lissajous figures that result from a phase difference between two input signals of the same frequency are often referred to as phase difference patterns. When the frequencies of the two input signals are not a 1:1 ratio, the Lissajous figures are generally used for frequency measurements.

To check the relative phase shift, proceed as follows:

1. Apply a sine wave signal to both the X and Y INPUT.

2. Center the trace horizontally and adjust the Y controls for 10 centimeters of vertical deflection. The pattern obtained should be similar to Figure 2-13.

3. The angle between the two signals is that angle whose sine is the ratio of A/B.

NOTE: To obtain full scale vertical deflection of 10 centimeters, it may be necessary to temporarily reduce the horizontal amplitude of the display. To accomplish this, set the X VOLTS/CM switch one step counterclockwise from its initial setting. Adjust the display for 10 centimeters of vertical deflection. Reset X VOLTS/CM switch to its original setting, recenter the display, and read dimension A in Figure 2-13.

SECTION 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

To simplify circuit description of the Type 704 Oscilloscope, functional block diagrams are provided as follows:

Figure 3-1. Y Input Circuit, Simplified Functional Block Diagram
Figure 3-2. Y Differential Amplifier, Functional Block Diagram
Figure 3-3. X Input Circuit, Simplified Functional Block Diagram
Figure 3-4. X Differential Amplifier, Functional Block Diagram
Figure 3-5. Trigger Circuit, Functional Block Diagram
Figure 3-6. Sweep Generator, Simplified Block Diagram

The circuit description will be keyed to the aforementioned illustrations. Emphasis is placed on the interrelation of circuits rather than on detail of operation. It is also recommended that the schematics at the rear of the manual be referred to in following the circuit description.

3-2. VERTICAL DEFLECTION SYSTEM

a. Input Circuit (Figure 3-1)

The Y Input Selector switch provides for the following selections:

1. Input A only.
2. Input B only; inverted polarity.
3. Inputs A & B for differential display.

A choice of AC or DC or AC STAB coupling is available for the above inputs. The AC STAB setting is used to minimize the low-frequency drift.

The Y VOLTS/CM switch consists of compensated RC networks permitting the desired attenuation of the input signal in 16 calibrated steps from 0.2 millivolts/cm to 20 volts/cm. In the CAL position, the calibrator signal is applied to the input of the input amplifier V101, and may be used to calibrate the oscilloscope. When gains are normalized, the peak-to-peak value of the calibrator waveform will indicate 5 centimeters of vertical deflection on the screen. The design of the calibrated attenuator provides a constant input impedance of 1 megohm and 47 picofarads at all settings of the Y VOLTS/CM switch.

The RC networks, R1001 and C1005, and R1003

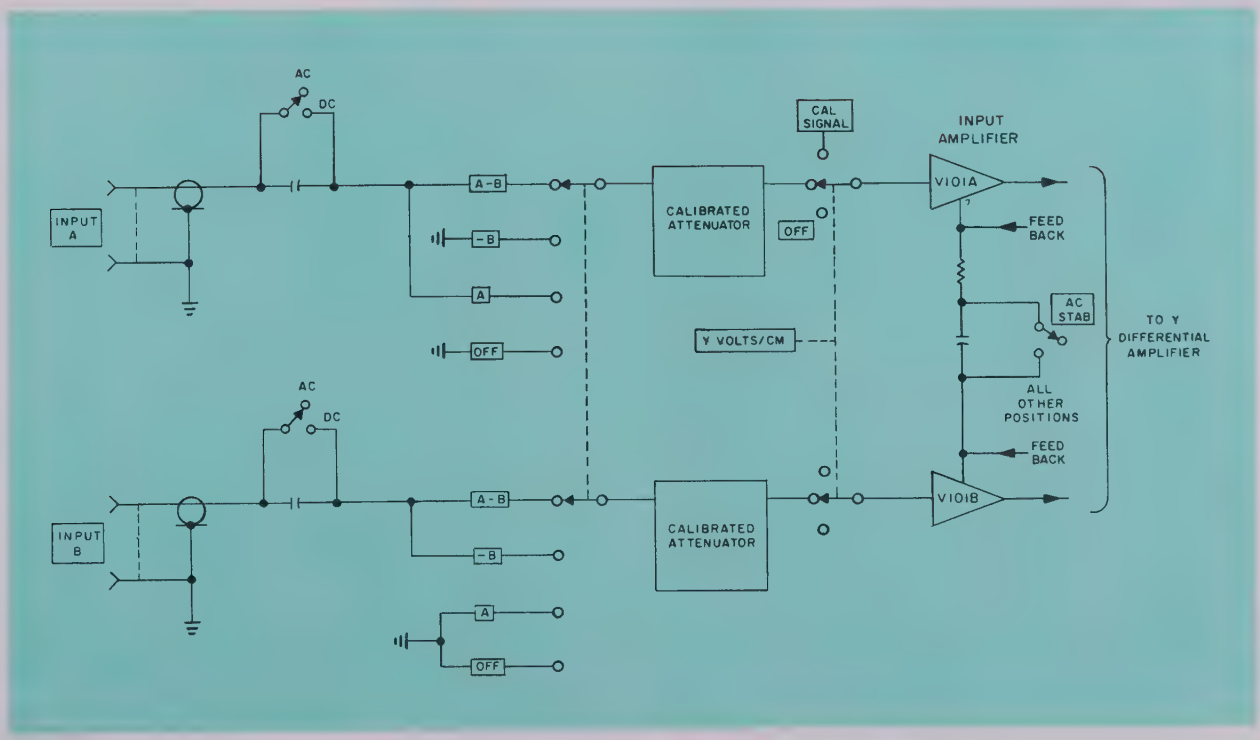


Figure 3-1. Y Input Circuit, Simplified Functional Block Diagram

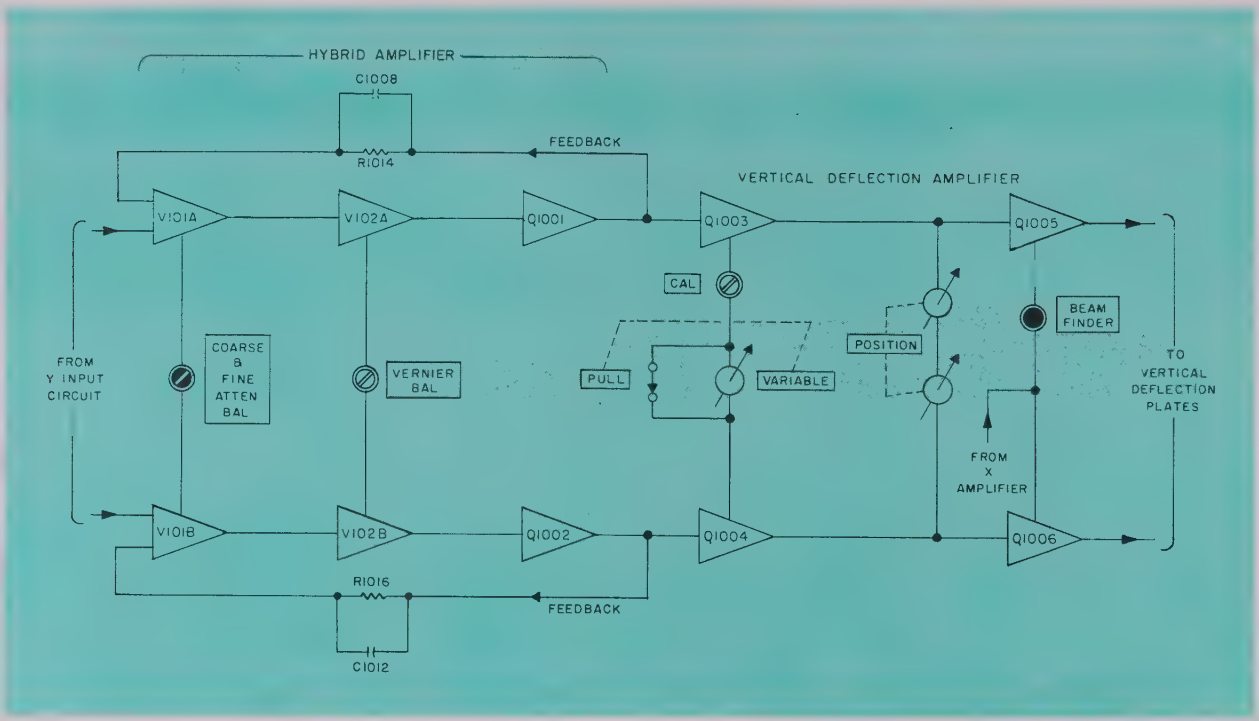


Figure 3-2. Y Differential Amplifier, Functional Block Diagram

and C1007, in series with the grid of V101A and V101B respectively, serve to protect the input circuit from damage due to excessive input voltage. The shunt capacitors preserve the high-frequency signal components.

b. Vertical Deflection DC Amplifier Operation (Figure 3-2)

The vertical deflection hybrid amplifier consists of an input stage V101, a cathode follower impedance transformation stage V102, and a transistorized output stage Q1001 and Q1002. Practically all of the collector current from Q1001 and Q1002 is fed back to the cathodes of the input amplifier V101, through R1014 and R1016. These resistors serve as the collector load for Q1001 and Q1002 and are also part of the feedback circuitry. Application of this technique simplifies circuitry and insures amplifier stability.

Since the most sensitive ranges of the Y VOLTS/CM switch are part of the feedback circuitry, both the input attenuator and the VARIABLE control require balancing. The FINE and COARSE ATTEN BAL adjustments are provided to equalize the cathode voltages of V101A and V101B. In this way, impedance changes between these cathodes, caused by the switching of the Y VOLTS/CM feedback resistors are not reflected as pattern positioning changes on the screen. Therefore, when the amplifier is balanced, there will be no depositioning of the trace.

The PULL VARIABLE control is connected between the emitters of transistors Q1003 and Q1004 in the gain control stage. Any difference in the dc level between the two emitters will cause the trace to shift vertically as the VARIABLE control is rotated. The VARIABLE control is deactivated when the knob is pushed in. To use the VARIABLE control, pull the knob and rotate it for the desired amplitude. Note that greater than calibrated gain may be obtained when the VARIABLE control is rotated fully clockwise.

The VERN BAL control is provided to equalize the collector voltage of Q1003 and Q1004 so that there is no depositioning of the trace on the screen when the PULL VARIABLE control is used.

For amplitude measurements, an internal calibrating voltage is applied to the vertical input dc amplifier, V101A, when the Y VOLTS/CM switch is set to CAL. This switch automatically disconnects the Y INPUT signal from the amplifier when the calibrator signal is applied. The Y CAL front-panel screwdriver control is used for normalizing the calibrated gain (5 cm) of the vertical deflection amplifier.

The X and Y OUTPUT LEVEL ADJ potentiometers (R1059 and R2066) are provided to set the X deflection plate average potential equal to the Y deflection plate average potential (approximately 118 volts above chassis ground).

The BEAM FINDER is a momentary contact switch that electrically reduces the output amplifier window and scales down the display. This action permits loca-

tion of the beam and then allows centering with the POSITION controls.

The BEAM FINDER control is extremely useful for locating the spot or trace under any condition of operation. If no spot or trace appears when the BEAM FINDER button is depressed, only two conditions can cause this: either the INTENSITY control has to be advanced or else the sweep is not running. It may aid the operator to set up the instrument for AUTOmatic triggering in an endeavor to obtain a trace on the screen.

The vertical deflection plates are driven directly from the transistorized amplifier Q1005 and Q1006.

3-3. HORIZONTAL DEFLECTION SYSTEM (Figures 3-3 and 3-4)

Since identical vertical and horizontal deflection amplifiers are employed in this oscilloscope, the previously discussed circuit description for the vertical deflection system is equally applicable for the X Deflection Circuit except for the X Input Selector switch.

The X Input Selector switch provides for the selection of time base or external signals for horizontal deflection. External signals may be applied to the X INPUT A and/or B terminals for single-ended or differential input. The time base signal is obtained from the sweep circuit and is applied to the X attenuator when the X Input Selector switch is set to SWP. The internal sweep may be expanded by factors up to 50 via the calibrated X deflection system; uncalibrated expansions up to 1000 times are possible.

A phase shift trimmer, C2023, is added across the output of the horizontal deflection amplifier. This trimmer enables an operator to optimize the phase shift differential between the X and Y amplifiers for a particular application.

3-4. TRIGGER CIRCUIT DESCRIPTION (Figures 3-5)

a. Trigger Input

The input to the trigger amplifier, V3001, may be selected from one of three sources via the Trigger Source switch as follows:

1. In EXT position, the signal is obtained from an external source through the TRIG IN front-panel connector.
2. In INT position, the signal is derived from the Y amplifier.
3. In LINE position, the signal is tapped from one side of the 6.3 VAC heater circuit.

A choice of AC, LF REJECT, or DC coupling is provided by the Trigger Coupling switch. In the AC position, the trigger signal is applied to a high-pass filter consisting of C3002, C3003, and R3003 providing a low-frequency cutoff of 80 cycles. The cutoff frequency is raised to 15 Kc in the LF REJECT position and the high-pass filter now consists of C3003 and R3002. In the DC position, the high-pass filters are disconnected and the triggering signal is applied directly to the trigger amplifier. The RC network, R3004 and C3004, in series with the grid of V3001, serves to protect the input circuit from damage to excessive input

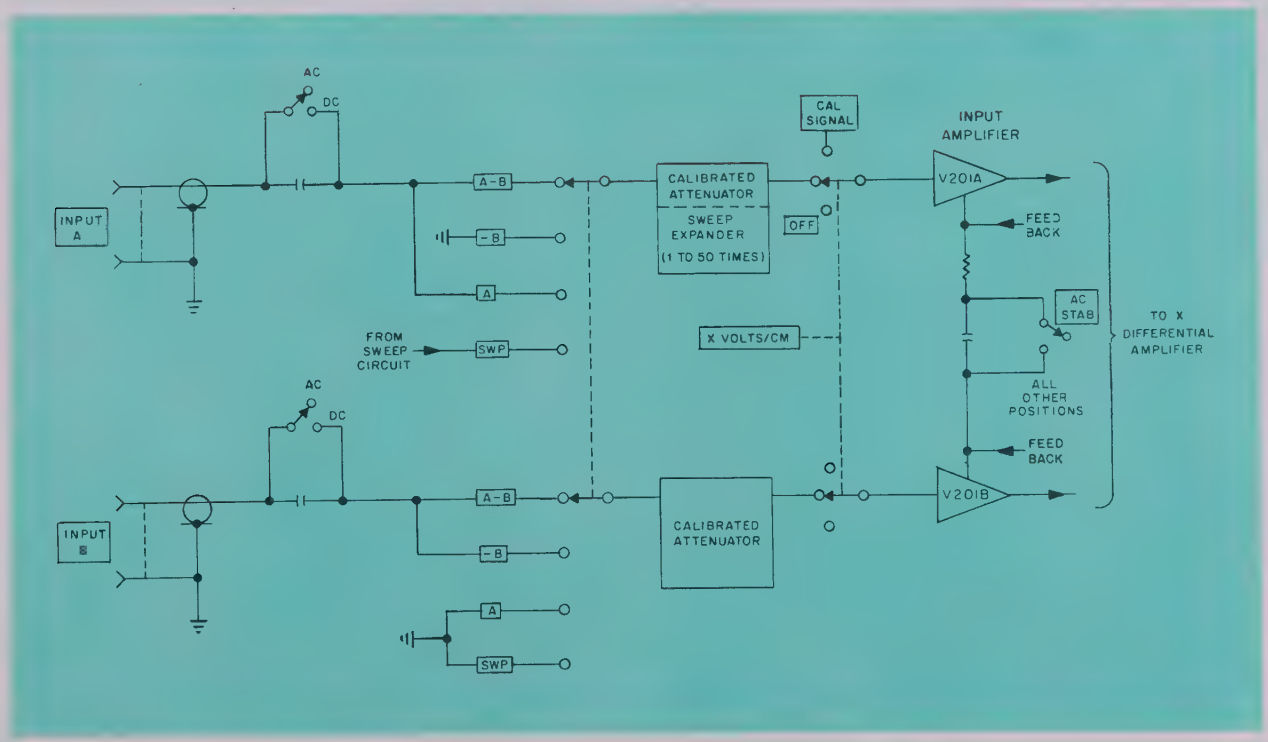


Figure 3-3. X Input Circuit, Simplified Functional Block Diagram

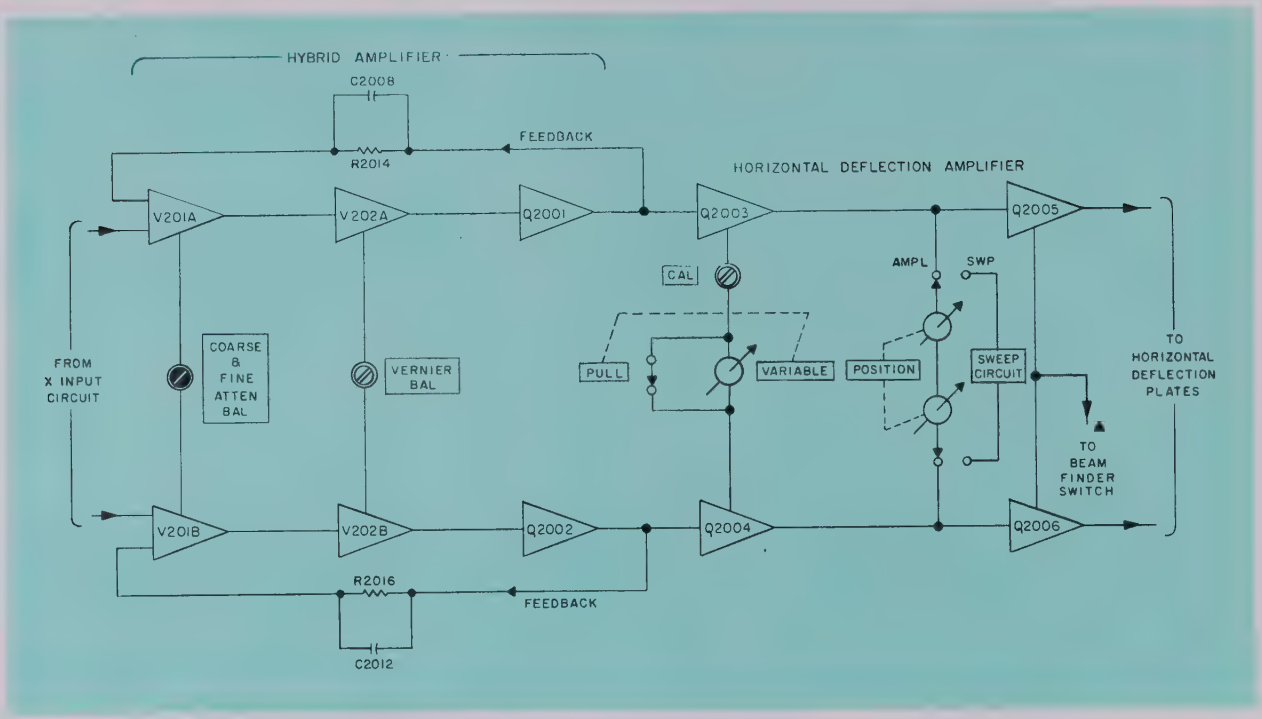


Figure 3-4. X Differential Amplifier, Functional Block Diagram

voltage. Shunt capacitor C3004, preserves the high-frequency signal component.

b. Trigger Amplifier

The trigger amplifier, V3001, is a cathode-coupled amplifier. Output is always taken from the B-Section plate (pin 6). For positive-going signals, connection is made to the grid of V3001B (pin 7), and for negative-going signals, connection is made to the grid of V3001A (pin 2). In each case, the opposite grid is connected to a dc bias source, adjustable by means of the TRIG LEVEL control R3006.

The TRIG LEVEL control is used to select the level of the triggering point for all settings of the Trigger Slope switch. When the TRIG LEVEL control is rotated fully clockwise to AUTO, the sweep is self-triggered in the absence of a triggering signal. As you rotate the control away from the AUTO position, the automatic sweep feature will cease. Continued rotation of this control will permit the operator to adjust

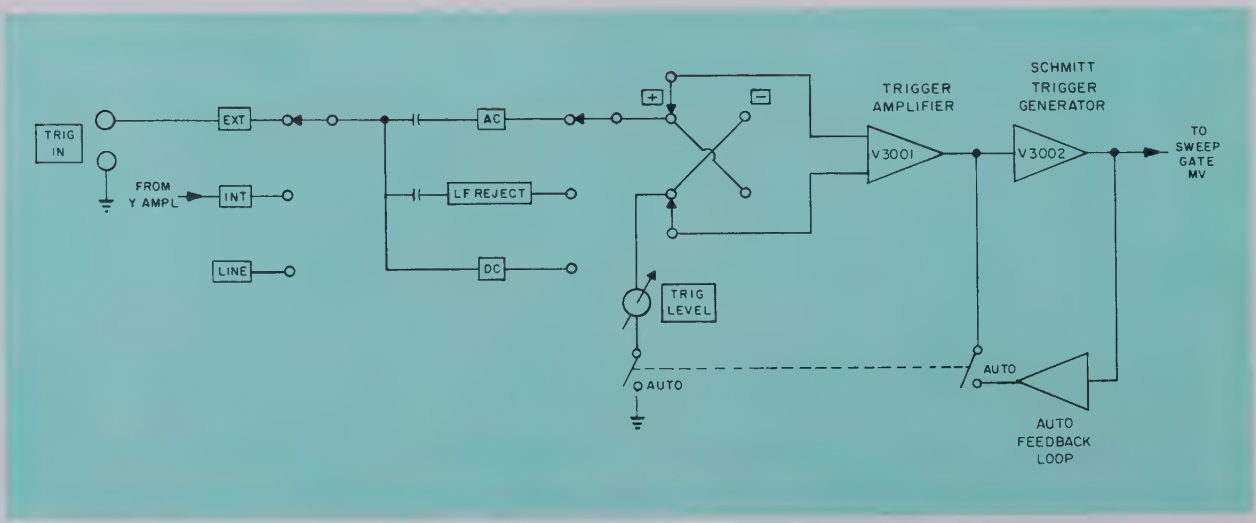


Figure 3-5. Trigger Circuit, Functional Block Diagram

the triggering level of the pattern within the limits specified in Table 1-1.

c. Schmitt Trigger Generator and Auto Triggering

The Schmitt Trigger Generator is essentially a regenerative amplifier signal level selector. It consists of a two-stage amplifier, V3002A and V3002B, having a dc plate-to-grid coupling from A to B amplifier and dc cathode-to-cathode coupling. The circuit has two stable states: the A side conducting, the B side at cutoff; the B side conducting, the A side at cutoff. The transition from one state to the other is abrupt, producing fast rise and fall times from each side of the circuit.

The dc voltage applied to the grid of V3002A determines which state the circuit will be in. Assume operation as follows: V3002A is conducting and V3002B at cutoff. V3002B will remain at cutoff until the amplitude of a positive-going signal applied to its grid reaches the threshold level of conduction. When this threshold level is exceeded, an abrupt transition from cutoff to full conduction will occur in V3002B. Simultaneously, V3002A will promptly stop conducting. V3002A and V3002B will revert to their original condition when the amplitude of the initiation signal falls slightly below the threshold level of conduction for V3002B.

In general, the threshold voltage is higher when moving the grid in a positive direction, and lower when moving the grid in the negative direction. The two different voltage levels are called the "upper and lower hysteresis limits" of the Schmitt Trigger Generator. The hysteresis offset basically represents the input peak-to-peak voltage sensitivity of the trigger system.

The initial A-side grid level can be positioned anywhere inside or outside of the hysteresis area, thus establishing the input voltage required to change the state of V3002A. The steady state grid bias of V3002A is normally determined by the TRIG LEVEL control setting.

When the TRIG LEVEL control is set to AUTO, the trigger amplifier is ac coupled to the input grid of the Schmitt Trigger Generator through C3007, and the feedback resistor, R3022, is connected between the grids of the Schmitt Trigger Generator. This causes V3002A and V3002B to flip back and forth yielding about 50 pulses per second in the AUTO position. Thus, a horizontal reference trace will appear on the screen even in the absence of an input signal.

3-5. SWEEP CIRCUIT (Figure 3-6)

a. Sweep Gate Multivibrator

The output from the Schmitt Trigger Generator is differentiated by C3009 and R3512 and applied to the grid of V3501B through turn-on diode CR3502.

The dc coupled bistable multivibrator, C3501A and V3501B, initiates the formation of the sweep after receiving a negative trigger from the Schmitt Generator. Diode CR3502 and the lockout circuit hold off subsequent triggering signals until after the sweep is com-

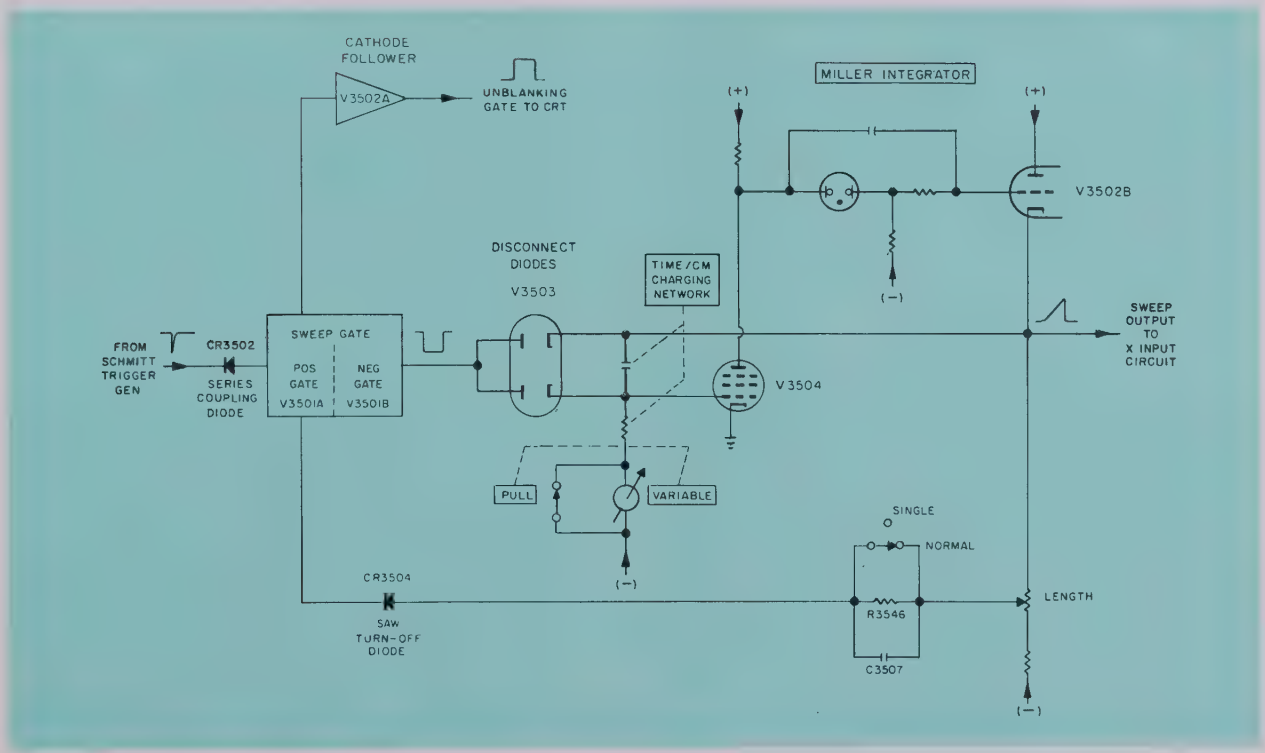


Figure 3-6. Sweep Generator, Simplified Diagram

pleted. In the quiescent state, V3501B is conducting and V3501A is at cutoff. V3501B forms a positive gate while V3501A forms a negative gate during the forward sweep interval.

CR3502 performs two functions: 1) it serves as a low-capacitance coupling diode to couple the negative trigger from the Schmitt Generator to initiate the sweep, and 2) it serves as a high back-impedance diode to decouple the Trigger Generator from the sweep gate multivibrator. After the bistable multivibrator has been triggered, it will revert to its original state as determined by the setting of the LENGTH adjustment, R3536.

b. Saw Generation

The saw generator is of the Miller "run-up" type, V3504. The negative output developed at the plate of V3501A is applied to the plates of the disconnect diodes, V3503A and V3503B. The anode voltages of these diodes are now below their cathodes, and the diodes no longer conduct. This action removes the restraint imposed on the sweep-charging network and now permits the selected sweep capacitor to charge linearly through the associated resistance network.

When the grid of the Miller integrator moves negatively, the plate voltage rises positively carrying the saw cathode-follower grid, cathode (V3502B) and timing capacitor in the same direction. Thus, the positive voltage swing on the opposite side of the timing capacitor tends to prevent the grid side from swinging negatively. It also increases the voltage to which the timing capacitor is trying to charge. The net result is to *straighten out* the charging curve (sweep voltage) by maintaining a constant current flow in the capacitor.

Since the grid of V3504 remains at a constant potential within a small fraction of a volt, the current through the charging resistor remains constant and the sweep timing capacitor thus charges at a constant rate. The resulting linear sawtooth waveform is applied to the horizontal deflection system when the X Input Selector switch is set to SWP.

The EXPANDER sector (green numerals) of the X VOLTS/CM switch provides horizontal magnification of the sweep about the screen center by factors of 1, 2, 5, 10, 20, and 50. Any portion of the expanded display may be observed by adjusting the POSITION control.

When a Trigger Mode switch is set to SINGLE, the saw turn-off diode CR3504 is isolated from the LENGTH potentiometer by R3546 and C3507. Thus only a single trace will now sweep across the screen when the sweep is triggered. At the end of its travel, the beam will rest off screen because the sweep gate multivibrator is locked in this position. To reset or rearm the sweep, flip the Trigger Mode switch from SINGLE to NORMAL and back to SINGLE position. Refer to the Operating Instruction Section for application of this technique.

c. Sweep Length

The sweep length, or the total duration of the sweep for any given sweep rate is determined by the setting of the Sweep LENGTH adjustment, R3536. A portion of the positive sawtooth voltage is fed back to the saw turn-off diode CR3504. If the Sweep LENGTH potentiometer is properly set, diode CR3504 will conduct when the positive-going excursion of the sawtooth has travelled 10.5 to 11 centimeters on the screen. This positive peak signal will then be conducted through diode CR3504 to the grid of V3502A. Upon receiving this positive pulse, the sweep gate multivibrator will revert rapidly to its original state with V3501B conducting, and V3501A at cutoff. The positive step from the plate of V3501 returns the disconnect diodes, V3503A and V3503B, back to their conducting state thus discharging the timing capacitors. The Miller circuit now returns to its quiescent level and is ready for the next trigger after the lockout time interval is completed.

d. Lockout Circuit

The lockout circuit prevents the sweep gate multivibrator from being triggered until the sweep retrace interval has reverted to the quiescent base level. The sweep does not retrace in zero time since the clamping of the Miller integrator timing capacitor is accomplished with a diode switch having a small impedance. The timing circuit discharge (saw retrace) takes longer than the flipping of the sweep gate multivibrator. Consequently, the trigger excitation pulses must be held off to prevent the formation of a new saw during the retrace interval of the preceding saw. This last or preceding sawtooth waveform must be permitted to retrace completely to its quiescent base which re-establishes the beam to the left-hand side of the CRT screen. This is accomplished by holding the cathode of the series-triggering diode, CR3502, at a suitable positive voltage for a given period after the completion of the sweep.

During the forward sweep interval, a portion of the positive gate voltage is fed back through R3544 to charge the lockout capacitor through coupling diode, CR3501.

During the return-trace interval, diode CR3501 is cut off and the lockout capacitor is discharged through R3516. The sweep gate multivibrator will not reset until the appropriate lockout timing capacitor has been discharged. The value of this capacitor is chosen to give lockout, beyond the time that the sweep has returned to rest at its initial starting point. The duration of the lockout interval is determined by the sweep charging time constant and the Miller integrator clamp. Consequently, the TIME/CM switch must also change the lockout circuit hold-off timing capacity. This technique prevents additional triggers from energizing the sweep during retrace interval.

The trigger coupling diode, CR3502, prevents triggers from disturbing the sweep gate multivibrator dur-

ing all of the sweep-forward interval and the lockout circuitry during the retrace interval.

e. Unblanking

The cathode-ray tube employed in this oscilloscope has two additional beam deflecting plates which cut off the electron beam independently of the control grid. Beam control pulses (trace brightening and retrace blanking pulses) can easily be dc coupled since these beam deflection plates are electrically close to ground. In conventional circuits these pulses must be coupled to a high-potential control grid.

The extra beam deflection plates are controlled by the sweep gate multivibrator, V3501. A positive gate is developed at the plate of V3501B and is coincident with the sweep forward time. This pulse is applied to the beam deflection plate of the cathode-ray tube through cathode follower V3502A. Hence the display is visible only during the forward sweep interval and is blanked during the retrace and lockout interval.

When the TIME/CM switch is set to OFF, one side of the sweep gate multivibrator is ungrounded thus enabling the sweep circuit and turning on the beam. The horizontal deflection amplifier may now be set up to receive external signals.

If blanking is desired with the X signal (electronic shutter operation), the TIME/CM switch may be set to any position except OFF, thus activating the sweep gate multivibrator. The degree of blanking is then controlled by settings of the TIME/CM controls. Refer to Operating Instructions Section for additional information.

3-6. LOW-VOLTAGE POWER SUPPLY

a. Power Transformer

Plate and heater power for this instrument is provided by a single power transformer, T4001. The primary is wound with two equal 115-volt windings that can be connected either in parallel for 115-volt operation, or in series for 230-volt operation. See Technical Summary, Table 1-1 for additional data.

b. Regulated Supplies

Four regulated supplies are provided with outputs as follows:

+160 volts, +59 volts, —12.6 volts, and —50 volts

All of the regulated supplies are of the constant-output voltage series-passing type. The basic reference for all of the regulated supplies is the fixed drop across V4004. This gas diode, V4004, maintains a constant voltage drop of about 85 volts across itself within a broad current range.

Operation of the other low-voltage regulated supplies is identical, so only the +160-volt supply is descibed. CR4001 to CR4004 are connected in a conventional bridge rectifier circuit. The rectified output is capacitively filtered by C4001. Resistor R4000 shunts the filter capacitor to leak off the charge when the instrument is turned off as a safety measure.

The filtered rectified output is applied to V4001 and V4002, series-passing tubes whose voltage drop is adjusted by the feedback voltage from R4008R through the dc amplifier Q4001. Assume the output voltage tends to decrease. This will lower the base voltage of the error detector amplifier Q4001. The resulting increase in voltage at the collector of Q4001 is applied to the control grid of the series-passing tubes. The resultant voltage change in the series-passing tubes V4001 and V4002, is such as to return the output voltage to its proper value.

Two series-passing tubes are connected in parallel to handle the required current. Cathode degenerative resistors R4005 and R4006 assure that each tube handles an equal amount of power.

c. Voltage Calibrator

The power-line frequency voltage from T4001 is applied to the base of voltage calibrator Q4007 through limiting resistor R4051. Negative and positive excursions will drive the transistor into and out of conduction at the line-frequency rate. The resulting waveform from the collector of Q4007 is applied to a voltage divider. The attenuated output is coupled to the vertical and/or horizontal amplifier when the appropriate VOLTS/CM switch is set to CAL.

3-7. CRT CIRCUIT

a. CRT Beam Control Circuits

The INTENSITY control R4059, part of the negative high-voltage divider, is used to vary the cathode-ray tube grid voltage to adjust the CRT cathode current. The FOCUS control R4503 varies the voltage at the focusing anode to set the second cross-over point right at the screen of the cathode-ray tube. The ASTIGmatism control R4523 is provided to vary the voltage in the astigmatism anode to focus the spot in both axes simultaneously.

b. High-Voltage Power Supply

Accelerating voltages for the cathode-ray tube are obtained by rectifying a 60 Kc high voltage produced by a vacuum-tube oscillator. V4501 is the oscillator tube connected as a Hartley oscillator with the primary of transformer T4501 as the tapped inductor, and C4511 as the capacitor.

The output of the oscillator is stepped up by T4501 and applied to a conventional half-wave rectifier and subsequently applied to the cathode-ray tube after being filtered to remove virtually all of the ripple content.

Regulation of the high-voltage negative supply is accomplished by sampling a portion of the rectified output and applying a correction signal back through V4502 to the screen grid of V4501. This action changes the amplitude of oscillations of V4501 and T4501 in such a manner as to restore the high voltage output to its preset level. Potentiometer R4505, HV ADJ, is provided to preset the output of the high-voltage supply to its proper level.

SECTION 4
PERFORMANCE ASSURANCE TEST

4-1. MAINTENANCE CHECK TO ASSURE PERFORMANCE

The test described in the paragraphs to follow should be performed by Instrument Test Departments and Maintenance Laboratories to certify proper performance of the instrument. These tests are divided into sections for simplification and to assist those test groups where complete checking is not mandatory, or where all test equipment is not available. Refer to Section 5, paragraph 5-6 for list of test equipment required.

NOTE

If this oscilloscope is checked by a receiving inspection laboratory, the tests outlined below are recommended to certify performance. This oscilloscope has been thoroughly tested and aged at the factory. Nevertheless, rough shipment, extreme environment, or long idle periods may necessitate minor adjustments of the controls. Hence it is suggested that the certifying engineer try the recommended adjustments not only for recentering the controls, but also to ascertain their range and to familiarize himself with this precision instrument. If, after performing all the tests outlined below, the instrument will not perform to specification, the assistance of the local Fairchild Field Engineering representative should be requested.

4-2. INITIAL SETUP OF TYPE 704 (Figure 4-1)

If the controls are set exactly as shown and performed in the sequence indicated in Figure 4-1, three cycles of the calibrator signal will be displayed on screen. The procedure just given is a good over-all check of the Type 704 Oscilloscope.

4-3. CHECKING THE POWER SUPPLY

1. Check the line fuse located in the front panel for proper value: 2 amperes for 115-volt operation; 1 ampere for 230-volt operation.
2. Examine the instrument for charred or mechanically damaged components. Correct all defects.
3. Apply power to the instrument through a variable voltage source (Variac, or an equivalent). Set the line voltage to 115 volts. (Double this value for 230-volt operation.)
4. Set up the oscilloscope to obtain six cycles of the calibrator signal.
5. Allow 30 to 60 minutes for warmup before making any adjustments.
6. Lower the line voltage until the display starts to drift or becomes erratic. The line voltage must be less than 105 volts at 60 cycles (210 volts for 230-volt operation). If instability is noted before the lower limit of the line voltage is reached, check operation of the low-voltage regulated power supplies as outlined in Section 4 of this Instruction Manual.
7. Raise the line voltage to 125 volts (250 volts for 230-volt operation). The display should remain stable and must not be erratic. If instability is noted before the upper limit of the line voltage is reached, check operation of the low-voltage power supplies.
8. Reset the line voltage to 115 volts (230 volts for 230-volt operation).

4-4. CHECKING X & Y INPUT SELECTOR SWITCHES

a. X Input Selector

1. Apply the output of a Ballantine Type 420 Calibrater set to 50 millivolts, to A and B INPUT connectors of the X Amplifier.
2. Preset front-panel controls as follows:

Control	Setting
X VOLTS/CM	5V
PULL VARIABLE	Pushed in
Y VOLTS/CM	OFF

3. All A-B settings of the AC, DC and AC STAB sectors of the X Input Selector switch should display less than 0.5 cm of deflection. All other settings of the switch should display 10 centimeters (±3%) of deflection.

b. Y Input Selector

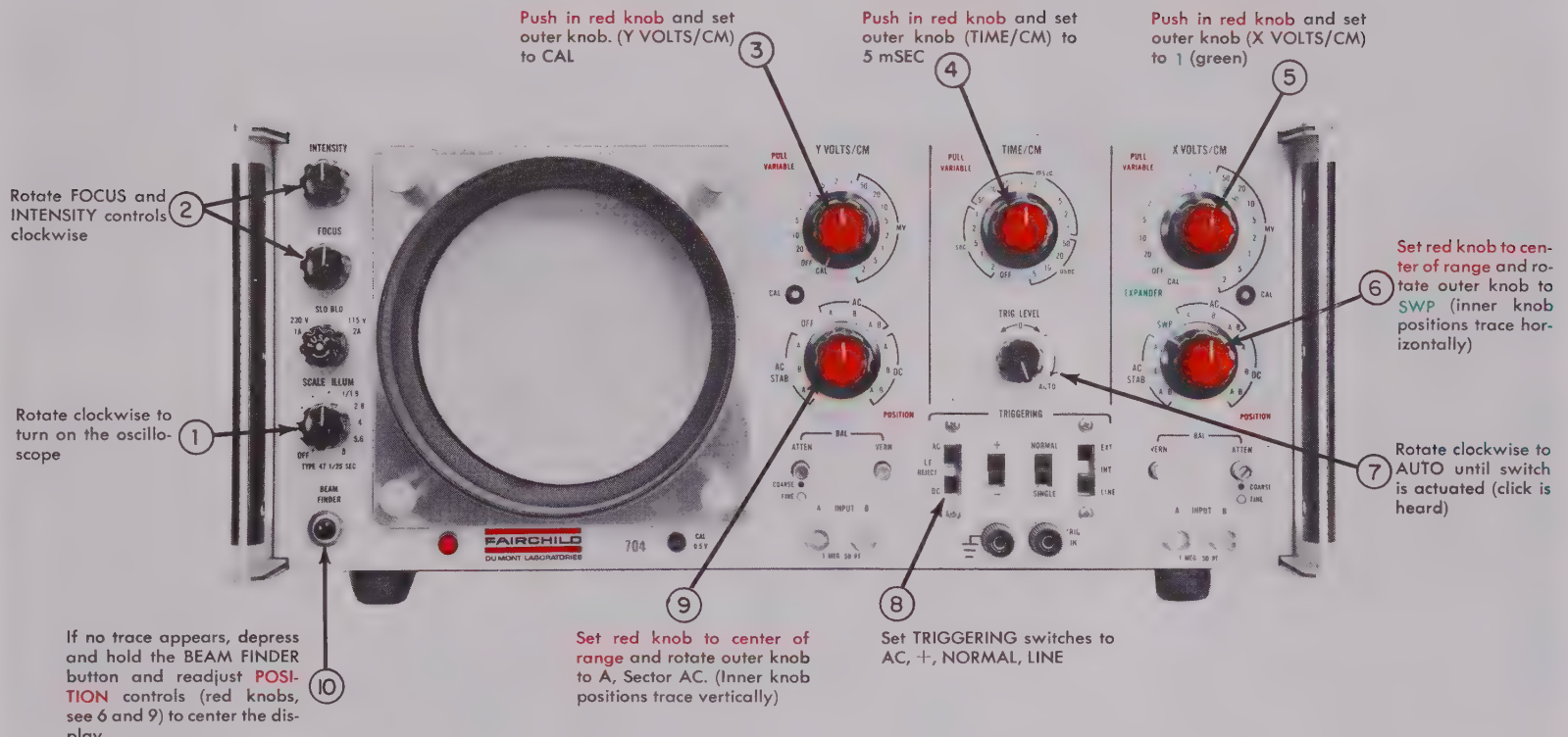
1. Apply the output of a Ballantine Type 420 Calibrator set to 50 millivolts, to A and B INPUT connectors of the Y Amplifier.
2. Preset front-panel controls as follows:

Control	Setting
EXPANDER (X VOLTS/CM)	1 (green numeral)
PULL VARIABLE	Pushed in
X Input Selector	SWP
Y VOLTS/CM	5V
PULL VARIABLE	Pushed in
TIME/CM	5 msec

3. All A-B settings of the AC, DC, and AC STAB sectors of the Y Input Selector switch should display

To obtain the calibrator display, set the controls exactly as shown and perform the numbered steps in sequence.

Use the same procedure when difficulty is experienced when obtaining a display. This will eliminate "cockpit" troubles due to misalignment of controls.


Push in red knob and set outer knob. (Y VOLTS/CM) to CAL
3
Push in red knob and set outer knob (TIME/CM) to 5 mSEC
4
Push in red knob and set outer knob (X VOLTS/CM) to 1 (green)
5
Rotate FOCUS and INTENSITY controls clockwise
2
Rotate clockwise to turn on the oscilloscope
1
Set red knob to center of range and rotate outer knob to SWP (inner knob positions trace horizontally)
6
Rotate clockwise to AUTO until switch is actuated (click is heard)
7
Set red knob to center of range and rotate outer knob to A, Sector AC. (Inner knob positions trace vertically)
9
Set TRIGGERING switches to AC, +, NORMAL, LINE
8
If no trace appears, depress and hold the BEAM FINDER button and readjust POSITION controls (red knobs, see 6 and 9) to center the display
10
Readjust INTENSITY & FOCUS controls (see 2) for a sharp pattern
11
INTENSITY
FOCUS
SCALE ILLUM
BEAM FINDER
Y VOLTS/CM
TIME/CM
X VOLTS/CM
TRIG LEVEL
TRIGGERING
POSITION
FAIRCHILD
DU MONT LABORATORIES
704

NOTE
X & Y ATTEN BAL & VERN BAL controls must be properly adjusted to obtain an on-screen trace. See paragraph 2-2.

Figure 4-1. Initial Setup of Type 704 Oscilloscope

less than 0.5 cm of deflection. All other settings of this switch should display 10 centimeters (±3%) of deflection except the OFF position which will display only the base line.

4-5. CHECKING X & Y ATTENUATOR SWITCHES

a. X Attenuator

1. Connect the output of a Ballantine Type 420 Calibrator, or equivalent, to X INPUT A connector on the Type 704 Oscilloscope.
2. Set X Input Selector switch to A, sector AC and push in PULL VARIABLE control.
3. Refer to accompanying Amplitude Calibration Chart for additional data.

b. Y Attenuator

1. Connect the output of a Ballantine Type 420 Calibrator, or equivalent, to Y INPUT A connector on the Type 704 Oscilloscope.
2. Preset front-panel controls as follows:

Control	Setting
X Input Selector	SWP
EXPANDER (X VOLTS/CM)	1 (green numeral)
PULL VARIABLE	Pushed in
Y Input Selector	A (AC)

3. Refer to accompanying Amplitude Calibration Chart for additional data.

4-6. CHECKING SWEEP CALIBRATION

1. Connect a Tektronix 180A Time-Mark Generator to the Y INPUT A connector of the oscilloscope through a properly terminated cable.
2. Sweep accuracy is checked by counting the positive peaks in the centered 8-centimeter portion of the CRT scale. Make sure the PULL VARIABLE knob is pushed in and refer to the accompanying Sweep Check Calibration Chart for additional data. All measurements indicated in this chart should fall within ±2 mm of the 9-centimeter marking.

AMPLITUDE CHECK CALIBRATION CHART

X/Y VOLTS/CM Setting	Generator Output Voltage	CM of Deflection ±3%
20V	10V	0.5
10V	10V	1
5V	10V	2
2V	10V	5
1V	10V	10
0.5V	5V	10
0.2V	2V	10
0.1V	1V	10
50 mV	500 mV	10
20 mV	200 mV	10
10 mV	100 mV	10
5 mV	50 mV	10
2 mV	20 mV	10
1 mV	10 mV	10
0.5 mV	5 mV	10
0.2 mV	1 mV	5

SWEEP CHECK CALIBRATION CHART

TIME-MARK GEN set to	TIME/CM set to	NUMBER OF POSITIVE PULSES*
5 µsec marker	5 µsec	9 timing markers
10 µsec marker	10 µsec	9 timing markers
10 µsec marker	20 µsec	17 timing markers
50 µsec marker	50 µsec	9 timing markers
100 µsec marker	0.1 msec	9 timing markers
100 µsec marker	0.2 msec	17 timing markers
500 µsec marker	0.5 msec	9 timing markers
1 msec marker	1 msec	9 timing markers
1 msec marker	2 msec	17 timing markers
5 msec marker	5 msec	9 timing markers
10 msec marker	10 msec	9 timing markers
10 msec marker	20 msec	17 timing markers
50 msec marker	50 msec	9 timing markers
100 msec marker	0.1 sec	9 timing markers
100 msec marker	0.2 sec	17 timing markers
100 msec marker	0.5 sec	9 timing markers
1 sec marker	1 sec	9 timing markers
5 sec marker	2 sec	7 timing markers

*Centered 8-cm portion of scale

SECTION 5
MAINTENANCE AND RECALIBRATION

5-1. INTRODUCTION

This section of the manual contains service information and procedures for internal adjustments.

WARNING

WHEN THE PANELS ARE REMOVED FROM THE INSTRUMENT FOR SERVICING, EXERCISE CAUTION WHILE THE POWER IS ON.

The lower-voltage busses are potentially more dangerous than the cathode-ray tube potential because of the high-current capabilities and large filter capacitors employed in these supplies. When you reach into the instrument with one hand while it is turned on, do not grasp the metal frame with the other hand. If possible, stand on an insulated floor and use insulated tools. It is advisable to ground the third lead in the power cord whenever the instrument is in use.

To gain access to the chassis for service, remove the top, bottom and rear panels. This will expose all of the transistors, tubes and service adjustments for normal maintenance.

5-2. REMOVAL AND REPLACEMENT OF PARTS

If it is necessary to order a replacement component from the factory, always give the Type Number and Serial Number of the instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in this manual. The Parts List gives the values, tolerances, ratings, and the factory part number for all electrical components used in the instrument. This will help to expedite service.

Since the production of this instrument, some of the parts may have been superseded by improved components. In such cases, the part numbers of these components will not be listed in your Parts List. However, if you order a part from the factory and it has been superseded by an improved component, the new part will be shipped in place of the part ordered.

It is the aim of the Fairchild organization to make available the most reliable commercial oscilloscopes within the state of the art and to provide services which will help the user to rapidly restore any of our equipment to its specified performance. Your local Field representative maintains a limited number of spare parts or the factory may be asked to air-ship replacement parts.

The procedure for replacing most parts in this instrument is obvious, therefore specific instructions for their removal are not required.

5-3. CATHODE-RAY TUBE REPLACEMENT

CAUTION

THE CATHODE-RAY TUBE SHOULD BE HANDLED WITH GREAT CARE TO PREVENT BREAKAGE AND/OR SERIOUS PERSONAL INJURY FROM FLYING GLASS.

To remove the cathode-ray tube, first remove the top and rear covers. Remove the bezel and loosen the tube clamp at the base of the CRT. Pull the cathode-ray tube straight out through the front panel. Install the new cathode-ray tube by the reverse of the foregoing procedure. Be sure to align the scale to the CRT trace and scan aperture.

After the cathode-ray tube has been replaced, it may be necessary to recalibrate. Special attention should be given to recalibration of the time-base sweep rates and to the amplifier sensitivities.

5-4. SERVICING HINTS

Although this is a complex electronic instrument, it may be localized to the following basic circuits:

1. Low-voltage Power Supply
2. High-voltage Power Supply
3. Cathode-ray Tube Circuit
4. Vertical Deflection Amplifier
5. Trigger Circuit
6. Time Base Circuit
7. Horizontal Deflection Amplifier

Whenever trouble occurs in this instrument, first try to localize it to one of these basic ciruits.

There is no simple way of locating troubles. An understanding of the functions of the circuits is the best help (see Circuit Description, Section 3). With an understanding of the circuits, you will be able to make a reasonable assumption of the general source of troubles from their symptoms.

As an aid in trouble-shooting this unit, refer to the simplified functional block diagrams given in Section 3, and of the schematics located at the rear of this Instruction Manual.

To keep electronic units operating at top performance, it is desirable to check the equipment at regular intervals. How often it is checked will depend on the installation and the conditions of operation. In general, portable units moved about constantly will require more frequent service than units fastened down permanently. For these regular checks, clean all dust

and dirt from the unit using a light air blast or soft brush.

In the event of improper equipment performance, the following suggestions are recommended:

1. If the instrument fails to operate, including the pilot light, check the source of power and determine that the power cord is firmly in place. Then check all fuses. A thermal cutout switch is incorporated in this unit. If the instrument has been working but has just stopped, it may have overheated and tripped the thermal cutout switch. The thermal cutout switch will reset itself when the interior temperature of the instrument drops to a safe value. Possible causes of overheating are: restriction of air circulation and high ambient temperature.

2. If the line voltage is within the specified limits, and one of the regulated power supply output voltages is not correct, check that particular regulator circuit.

Note: Always check the power supplies in the following order: +160V, —50V, +59V, —12.6V and —2400V.

3. If the pilot light operates but there is no spot visible, there is a possibility that the spot is positioned off the screen. Depress and hold the BEAM FINDER button and adjust the POSITION controls to center the beam.

4. Try to set up the oscilloscope as depicted in Figure 2-5 entitled "Initial Setup of Type 704 Oscilloscope" in Section 2 of this Instruction Manual.

5. Localizing the trouble is made easier by use of an oscilloscope to check waveforms. Use a high-impedance probe while trouble shooting.

6. Maintain a high quality of workmanship. Use a clean bench and soldering iron; keep solder joints smooth and bright; do not overheat any component while soldering. Use heat sinks while soldering semiconductors. The use of a 30-watt iron such as a Hexacon Type 26S is recommended.

7. When using the accessory probes or adapters, be sure the trouble is *not* originating in the accessory before suspecting the oscilloscope itself.

8. Once the defective stage has been localized, the component or components causing the trouble can be located by tube and component substitution or by voltage measurements. Key voltage measurements are shown on the over-all schematics at the rear of this manual.

9. Sometimes the aftermath of tube or transistor failure yields the charred resistors or over-stressed capacitors. A visual inspection will usually expose the damaged component requiring replacement.

10. Identification of replaceable components including all those mounted on assembly boards, are shown in photographs in this section.

5-5. PREVENTIVE MAINTENANCE

This unit is a stable instrument that will provide many hours of trouble-free operation. However, to insure the reliability of measurements, we suggest that you recalibrate the instrument after each 500 hours of operation or every six months if used intermittently. Also, the calibration of a unit should always be checked and adjusted as necessary after the repair or replacement of any component in the unit. The complete adjustment procedure for this instrument is given in this section of the Instruction Manual. The internal calibrator or a more precise standard may be employed to set the front-panel screwdriver CAL controls.

Note: The regulated power supplies should always be checked before calibrating any part of the instrument.

5-6. TEST EQUIPMENT REQUIRED FOR SERVICE ADJUSTMENTS

a. Introduction

The adjustments outlined in the following paragraphs are based on the test procedure followed at the factory.

Normally only periodic adjustment of the CAL and BALance controls will be necessary. The procedure outlined in this manual should be followed. The attenuators are factory aligned and should not be touched unless there is a positive indication that they require adjustment.

All adjustments should be made at mid-line voltage, 115V/230V. ±2%.

b. Test Equipment Required (Equivalent may be substituted)

Type	Description
Volt-ohmmeter	Simpson Model 260 20,000 ohms/volt sensitivity
Square Wave Generator	Tektronix Type 105A
Time Mark Calibrator	Tektronix Type 180A
Standard Amplitude Calibrator	Ballantine Type 420
High Voltage Meter	Sensitive Research Model DCH-1
Signal Generator	Hewlett-Packard Type 650A with 600-ohm termination
Autotransformer	Powerstat, Variac; capable of varying line voltage of the instrument being calibrated from 103 volts to 127 volts
AC Voltmeter	Weston Model 433
Digital Voltmeter	John Fluke Model 801B; 0.1 to 500 volts
Alignment Tool	Insulated screwdriver (from Type 7011 Tool Kit)
Micro-Miker	Kay Lab Model 402B

CAUTION

Always use insulated tools while working or making adjustments on the unit when power is on. The transistors in the oscilloscope may be damaged if over-voltaged by accidental grounding of one or more elements. Exercise caution and turn off power when making repairs.

5-7. ADJUSTING THE LV AND HV POWER SUPPLIES

Connect the autotransformer to a suitable power source and connect the oscilloscope output to this transformer. Turn on the instrument and set the output for the nominal operating voltage of the oscilloscope using the Weston Model 433 AC voltmeter (115V for 115-volt operation or 230V for 230-volt operation). Allow 30 to 60 minutes of warmup time before making any adjustments. Preset the front-panel controls as indicated.

Control	Setting
Y VOLTS/CM	CAL
Y Input Selector	OFF
TIME/CM	5 msec
TRIG LEVEL	AUTO
X VOLTS/CM	1 (green numeral)
X Input Selector	SWP
TRIGGERING	AC, +, NORMAL, INT
PULL VARIABLE	All 3; pushed in

Use a John Fluke Voltmeter and adjust or check the supplies in the sequence listed.

1. Set the +59V ADJ (R4008F) to center of its range.
2. Adjust R4008R for +160 volts.
3. Adjust R4008F for +59 volts.
4. Check −50V supply; tolerance is ±0.8 volt.
5. If the −50V supply is more negative than − 50.8 volts, connect R4016 (see Figure 4-lb.) to + supply (white-red lead).
6. If the −50V supply is less negative than −49.2 volts, connect R4016 to −50V supply (white lead). In each case readjust R4008R (+160V ADJ).
7. Adjust HV ADJ potentiometer, R4505, for −2400 volts.

5-8. CRT ADJUSTMENTS

a. Astigmatism (R4523)

1. Set up the oscilloscope for normal operation using the calibration signal.
2. Adjust ASTIG potentiometer, R4523 simultaneously with the FOCUS control until optimized focusing of the pattern is obtained in both the horizontal and vertical plane.
3. Maintain normal intensity while making these adjustments.

b. Graticule External to CRT

To align the trace to the graticule, proceed as follows:

1. Use AUTOmatic sweep with no signal applied to the vertical channel.
2. Loosen CRT clamp.
3. Center the trace and rotate CRT so that the trace is parallel to the center line of the graticule.
4. Tighten CRT clamp.

c. Graticule Internal to CRT (R4523R)

1. Where the graticule is internal to the CRT, align the tube so that the horizontal center line is perpendicular to the left side of the frame using a suitable fixture. Clamp the CRT.
2. Set up instrument for automatic sweep with no signal applied to the vertical channel.
3. Adjust R4523R (located as part of ASTIG control in rear of power supply chassis) until the trace is parallel to the center line of the graticule.

5-9. X (R2066) AND Y (R1059) OUTPUT LEVEL ADJUSTMENTS

The X and Y OUTPUT LEVEL ADJ potentiometers are provided to set the X deflection plate average potential equal to the Y deflection plate average potential.

1. Temporarily short the collectors of Q2005 and Q2006 together (located in the X amplifier).
2. Connect the John Fluke Voltmeter between the now common collectors to ground.
3. Adjust the X OUTPUT LEVEL ADJ potentiometer, R2066 for 118 volts. A range of 116V to 120V may be permitted to eliminate on-screen amplifier cutoff.
4. Disconnect the meter and the X deflection plate short.
5. Temporarily short the collectors of Q1005 and Q1006 together (located in the Y amplifier).
6. Repeat steps 2, 3, and 4 except adjust Y OUTPUT LEVEL ADJ potentiometer R1059 for 118 volts.

5-10. VERNIER AND ATTENUATOR BALANCE ADJUSTMENTS

When the VERN and ATTEN BAL controls are properly adjusted, there will be no depositioning of the trace when the VOLTS/CM and PULL VARIABLE controls are used. These are front-panel controls and their application will be found in Section 2, Operating Instructions, of this manual.

5-11. NORMALIING X & Y AMPLIFIERS

The X and Y CAL front-panel screwdriver controls are employed to set up the amplifiers for a specific deflection.

To properly normalize the gain of this instrument, proceed as follows:

1. Preset front-panel controls as indicated:

Control	Setting
X VOLTS/CM	CAL
Y VOLTS/CM	CAL
TIME/CM	OFF
PULL VARIABLE	All 3; pushed in

2. Adjust the Y CAL control for precisely 5 cm of vertical deflection.

3. Adjust the X CAL control for precisely 5 cm of horizontal deflection.

5-12. PHASE SHIFT ADJUSTMENT (C2023)

A phase shift trimmer capacitor, C2023 is added across the output of the horizontal deflection amplifier and is adjusted when necessary for optimum phase differential between the X and Y amplifiers in a particular application. Normally, C2023 is set to minimum and does not require recalibration since its adjustment applies only to the X-Y comparison measurement on display.

If phase shift adjustment is required for certification, proceed as follows:

1. Apply a 100 Kc sine wave signal from a properly terminated generator to both the X and Y Input connectors.

2. Set X and Y VOLTS/CM switches to 5 mV and adjust generator for 8 centimeters of deflection.

3. Adjust C2033 for a single diagonal line.

5-13. X ATTENUATOR ALIGNMENT (C2103, C2104, C2108 and C2109)

The attenuators are factory aligned and should not be touched unless there is positive indication that they require adjustment. If adjustment is necessary, follow the steps as outlined.

To properly align the X attenuators, proceed as follows:

1. Preset front-panel controls as follows:

Control	Setting
X Input Selector	A(AC)
X VOLTS/CM	0.5 volt
Y Input Selector	A(AC)

2. Couple the internal sawtooth signal from pin 3 of V3502 to the Y INPUT A connector.

3. Set up the oscilloscope for external triggering and hook up the Tektronix Type 105A Square Wave Generator to the X INPUT A connector.

4. Set square wave generator for 25 Kc and adjust C2103 for best flat top.

5. Turn X VOLTS/CM switch to 50 mV.

6. Set square wave generator for 2.5 Kc and adjust C2104 for best flat top.

7. Set X Input Selector switch to B, sector AC, and hook up the square wave generator to the X INPUT B connector.

8. Turn X VOLTS/CM switch to 0.5 volt.

9. Set square wave generator for 25 Kc and adjust C2108 for best flat bottom.

10. Turn X VOLTS/CM switch to 5 mV.

11. Set square wave generator for 2.5 Kc and adjust C2109 for best flat bottom.

NOTE: A tabulation check of all ranges of the attenuator is shown in the *Amplitude Check Calibration Chart* located in Section 4 of this Instruction Manual.

5-14. Y ATTENUATOR ALIGNMENT (C1103, C1104, C1108, and C1109)

Since this oscilloscope is designed with identical X and Y deflection amplifiers, the general information at the beginning of paragraph 5-13 is applicable.

To properly align Y attenuators, proceed as follows:

1. Preset front-panel controls as follows:

Control	Setting
X Input Selector	SWP
X VOLTS/CM	1 (green numeral)
Y Input Selector	A (AC)
Y VOLTS/CM	0.5 volt

2. Set up the oscilloscope for external triggering and hook up the Tektronix Type 105A Square Wave Generator to the Y INPUT A connector.

3. Set square wave generator for 25 Kc and adjust C1103 for best flat top.

4. Turn Y VOLTS/CM switch to 50 mV.

5. Set square wave generator for 2.5 Kc and adjust C1104 for best flat top.

6. Set Y VOLTS/CM switch to B, sector AC and hook up the square wave generator to the Y INPUT B connector.

7. Turn Y VOLTS/CM switch to 0.5 volt.

8. Set square wave generator for 25 Kc and adjust C1108 for best flat bottom.

9. Turn Y VOLTS/CM switch to 5 mV.

10. Set square wave generator for 2.5 Kc and adjust C1109 for best flat bottom.

NOTE: A tabulation check of all ranges of the attenuator is shown in the *Amplitude Check Calibration Chart* located in Section 4 of this Instruction Manual.

5-15. X INPUT CAPACITANCE ADJUSTMENT (C2003 and C2004)

1. Preset front-panel controls as follows:

Control	Setting
X VOLTS/CM	0.5 volt
X Input Selector	A (AC)

2. Connect Micro-Miker to X INPUT A connector. Record reading; it should be 50 pf, ±3 pf.
3. Turn X VOLTS/CM switch to 20 mV.
4. Adjust C2003 for the same input capacity as recorded in step 2.
5. Check input capacity of all ranges from 20 volts to 20 mv. They should be within ±1 pf of the recorded capacity in step 2.
6. Turn X Input Selector switch to B (AC).
7. Connect Micro-Miker to X INPUT B connector.
8. Turn X VOLTS/CM switch to 0.5 volt. Record reading; it should be within ±2 pf of INPUT A.
9. Turn X VOLTS/CM switch to 20 mV.
10. Adjust C2004 for the same input capacity as recorded in step. 8.
11. Check input capacity of all ranges from 20 volts to 20 mv. They should be within ±1 pf of the recorded capacity in step. 8.

5-16. Y INPUT CAPACITANCE ADJUSTMENT (C1003 and C1004)

1. Preset front-panel controls as follows:

Control	Setting
Y VOLTS/CM	0.5 volt
Y Input Selector	A (AC)

2. Connect Micro-Miker to Y INPUT A connector. Record reading; it should be 50 pf, ±3 pf.
3. Turn Y VOLTS/CM switch to 20 mV.
4. Adjust C1003 for the same input capacity as recorded in step 2.
5. Check input capacity of all ranges from 20 volts to 20 mv. They should be within ±1 pf of the recorded capacity in step. 2.
6. Turn Y Input Selector switch to B (AC).
7. Connect Micro-Miker to Y INPUT B connector.
8. Turn Y VOLTS/CM switch to 0.5 volt. Record reading; it should be within ±2 pf of INPUT A.
9. Turn Y VOLTS/CM switch to 20 mV.
10. Adjust C1004 for the same input capacity as recorded in the previous step 8.
11. Check input capacity of all ranges from 20 volts to 20 mv. They should be within ±1 pf of the recorded capacity in step 8.

5-17. SWEEP ADJUSTMENTS

a. Sweep Expansion Balance (R2057)

When the SWP EXP BAL potentiometer is properly adjusted there will be no off-screen displacement of the trace when the oscilloscope is switched from internal sweep to externally applied signals. To adjust, proceed as follows:

1. Set EXPANDER sector of X VOLTS/CM switch to 1 (green numeral).
2. Temporarily short the sweep output to ground at the junction of R3521 and R3522.
3. Adjust SWP EXP BAL potentiometer, R2057, until the trace is centered.
4. Remove the short.

b. Sweep Length Adjustment (R3536)

The sweep LENGTH potentiometer is provided so that the trace may be adjusted to display a horizontal scan of 10 to 11.5 centimeters when oscilloscope is set up for calibrated unexpanded sweep.

1. Set up the oscilloscope to obtain a normal calibrator display on the screen.
2. Adjust sweep LENGTH potentiometer, R3536, until the display occupies 10.5 cm of horizontal deflection.

c. Slow Sweep Calibration Adjustment (R3502)

The SWP CAL potentiometer is provided to standardize accurately the steps of the TIME/CM switch.

Regular Method

1. Apply a 5 millisecond time-marker signal from a Tektronix Type 180A Generator through a properly terminated cable to Y INPUT A connector.
2. Set TIME-CM switch to 5 msec and the EXPANDER sector of the X VOLTS/CM switch to 1 (green numeral).
3. Push in all three PULL VARIABLE controls.
4. Adjust SWP CAL potentiometer, R3502, for one pulse per centimeter.

Alternate Method

1. Set up the oscilloscope to obtain the normal calibrator pattern on the screen.
2. Set TIME/CM switch to 5 msec and the EXPANDER sector of the X VOLTS/CM switch to 1 (green numeral).
3. Push in all three PULL VARIABLE controls.
4. Adjust SWP CAL potentiometer, R3502, until 3 cycles of the calibrator signal appear precisely in 10 centimeters (60-cycle line).

d. Fast Sweep Calibration Adjustment (C3501)

1. Apply a 5-microsecond time-markers signal from a Tektronix Type 180A Generator through a properly terminated cable to the Y INPUT A connector.
2. Adjust the Y VOLTS/CM switch to give the display a vertical amplitude of about 4 centimeters.
3. Set TIME/CM switch to 5 μsec and push in PULL VARIABLE control.
4. Using an insulated screwdriver, adjust trimmer C3501 for one pulse per centimeter.

NOTE: A tabulation check of all sweep ranges is shown in the *Sweep Check Calibration Chart* located in Section 5 of this Instruction Manual.

5-18. 230-VOLT OPERATION

Instructions for changing from 115V to 230V operation are shown on Fig. 5-1a. Also refer to Power Supply schematic, Sheet 4 in the rear of this Instruction Manual.

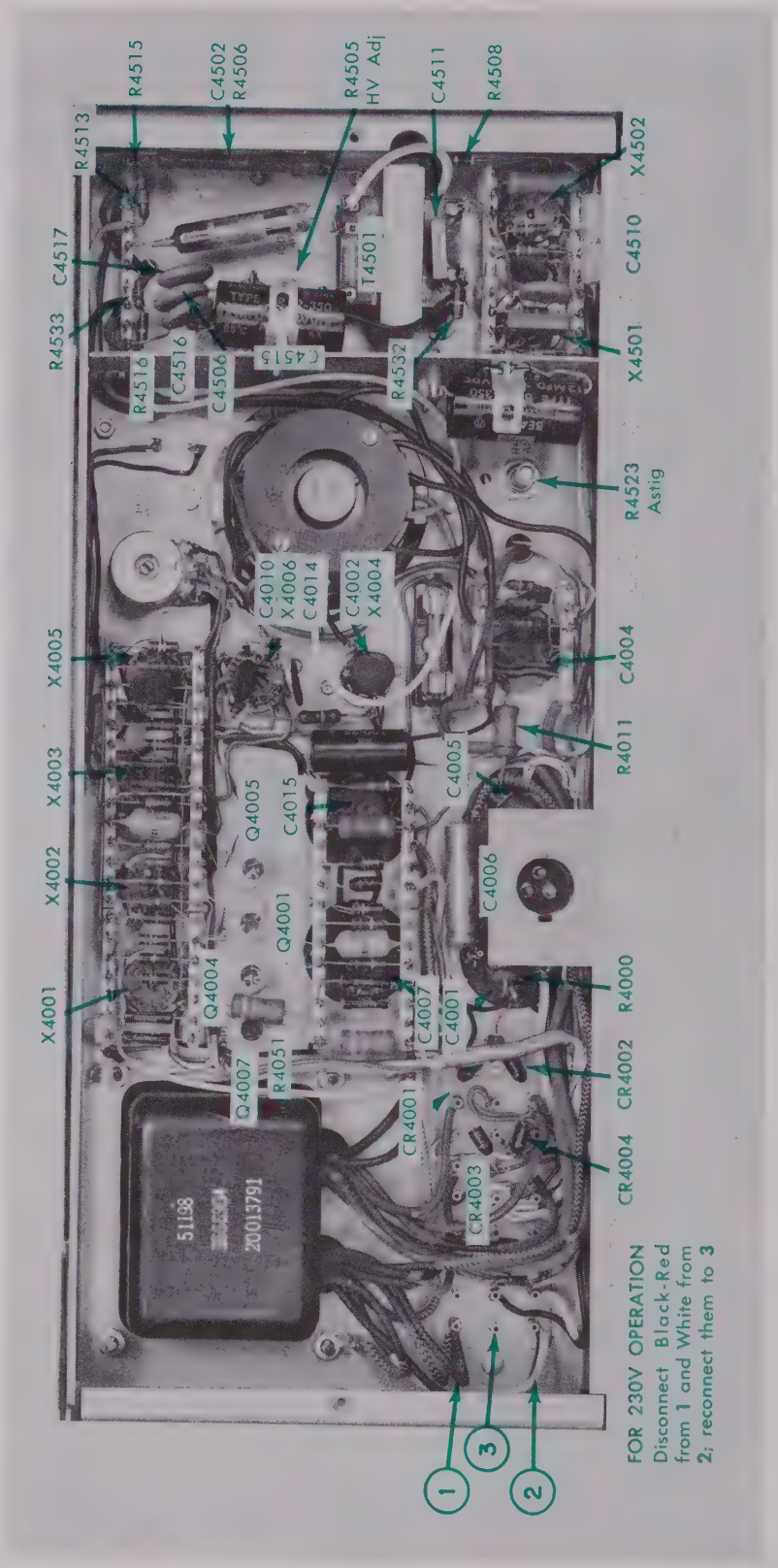


Figure 5-1a. Identification of Replaceable Components

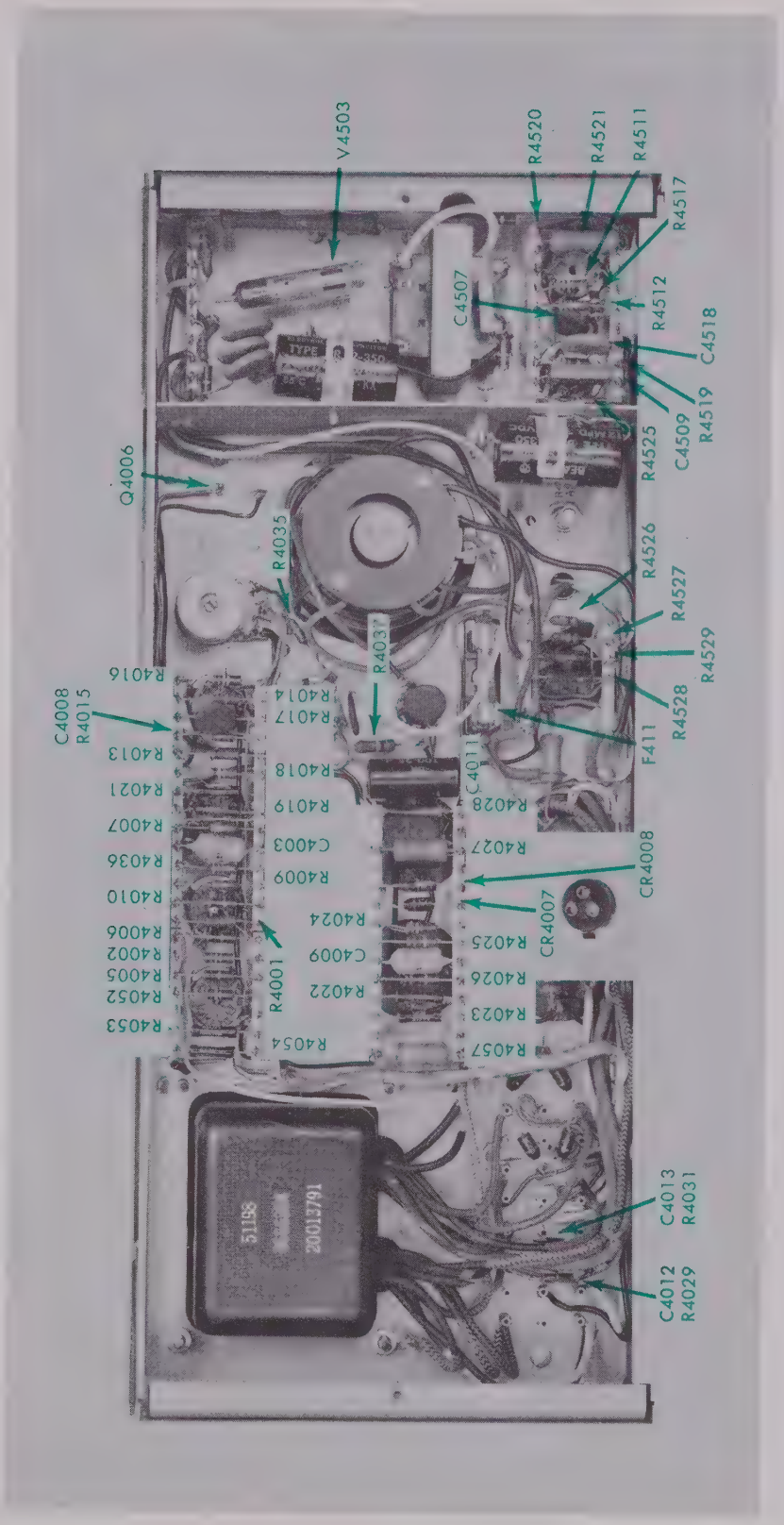


Figure 5-1b. Identification of Replaceable Components

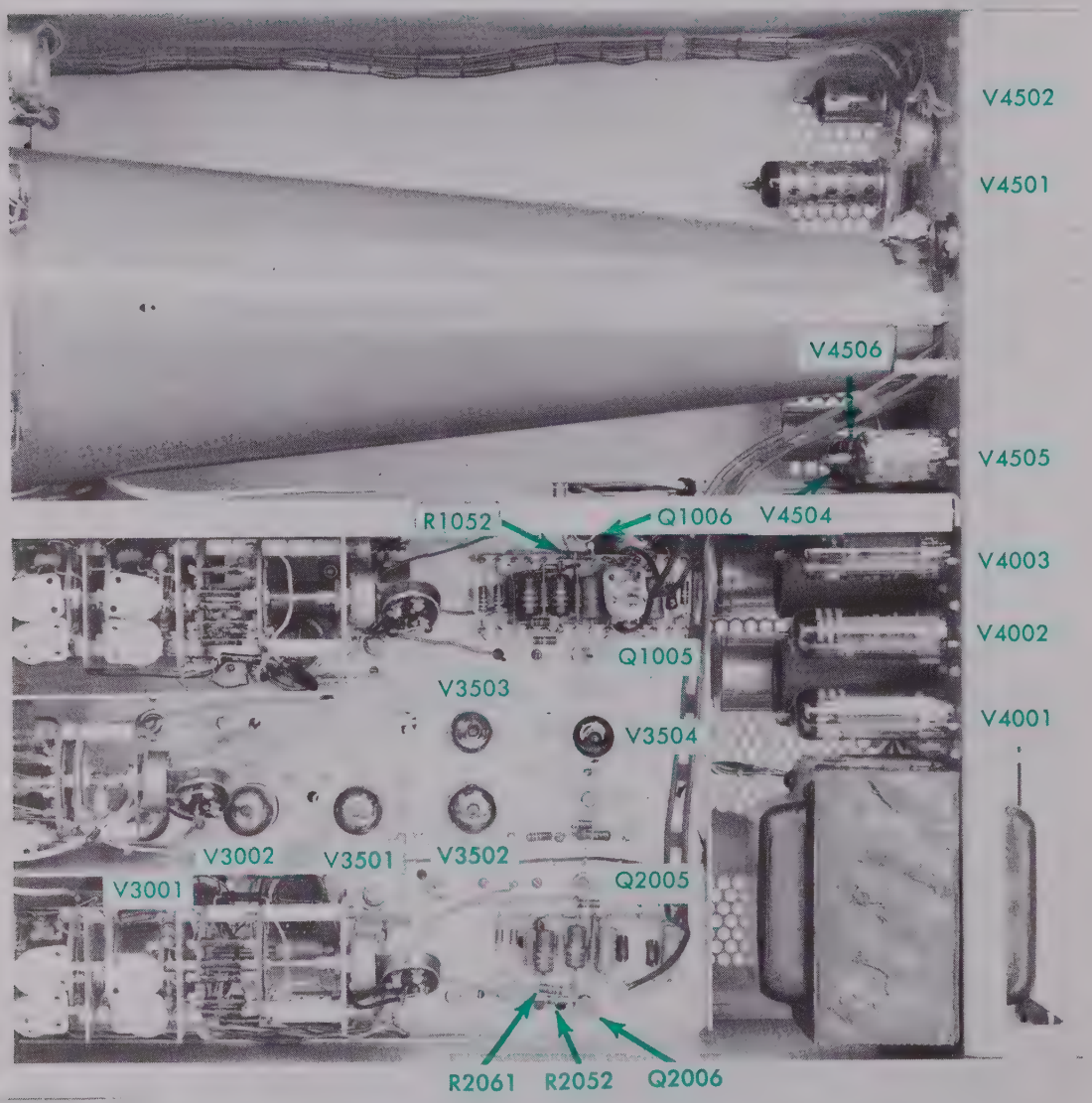


Figure 5-2a. Identification of Replaceable Components

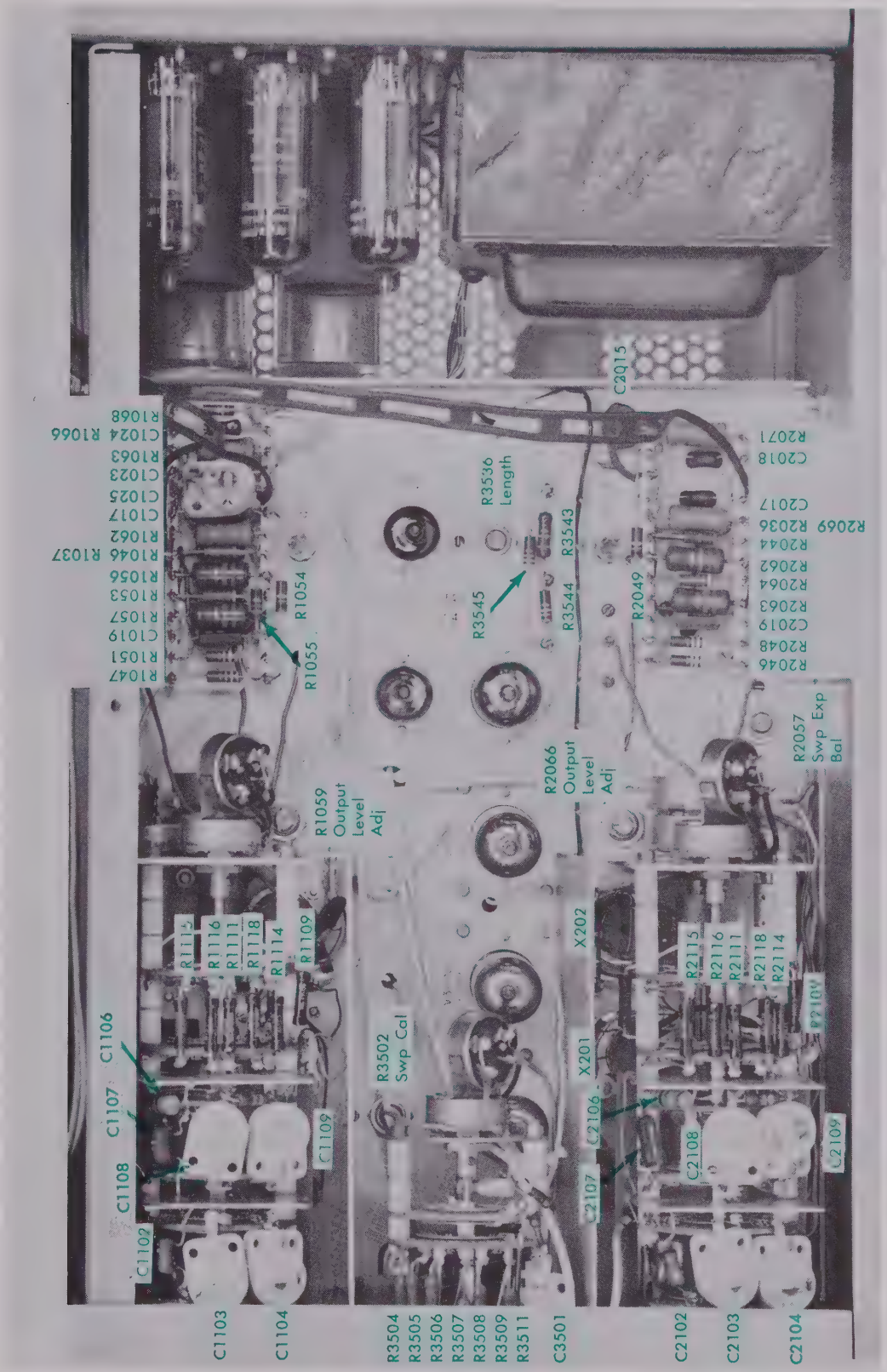


Figure 5-2b. Identification of Replaceable Components

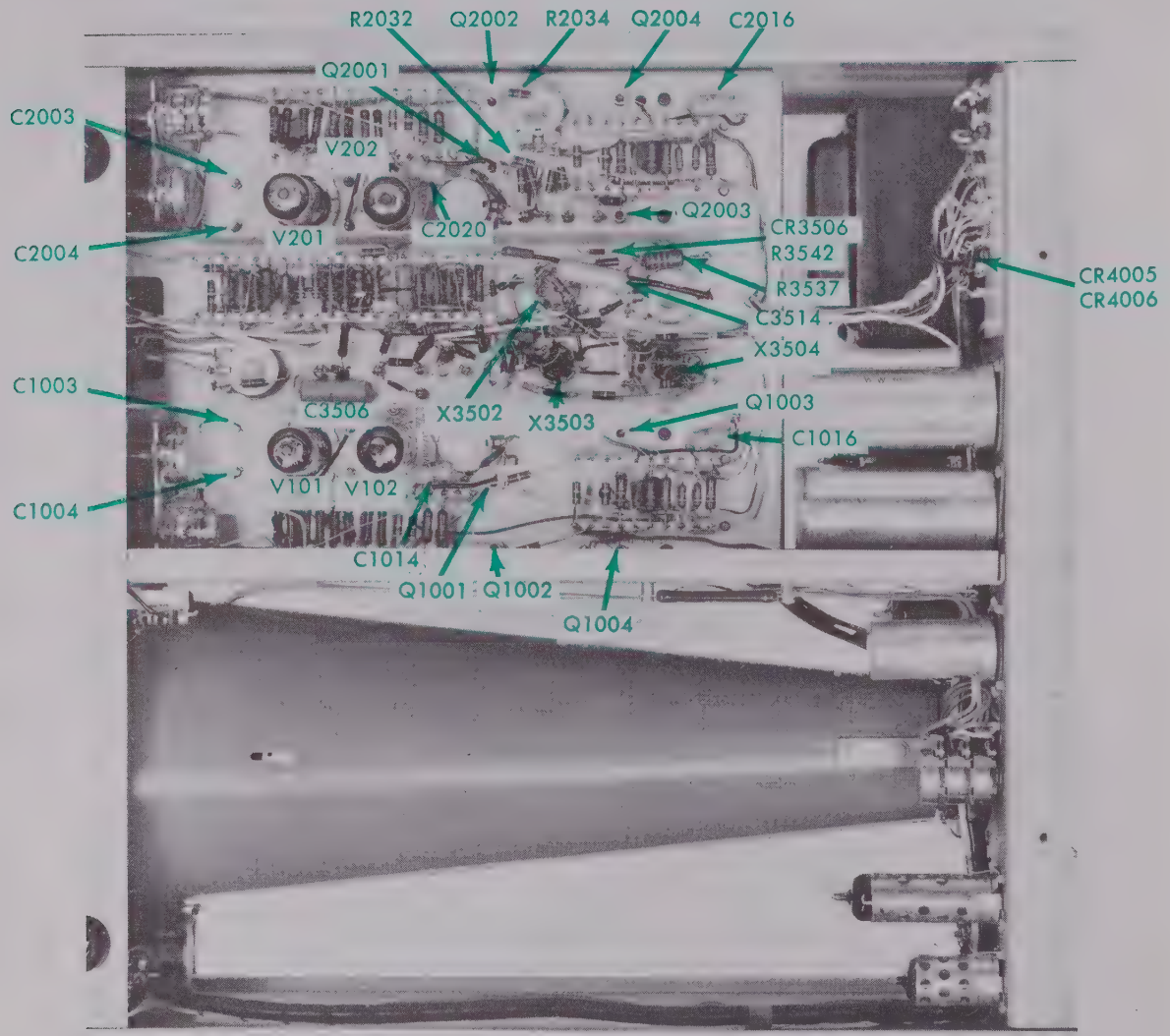


Figure 5-3a. Identification of Replaceable Components

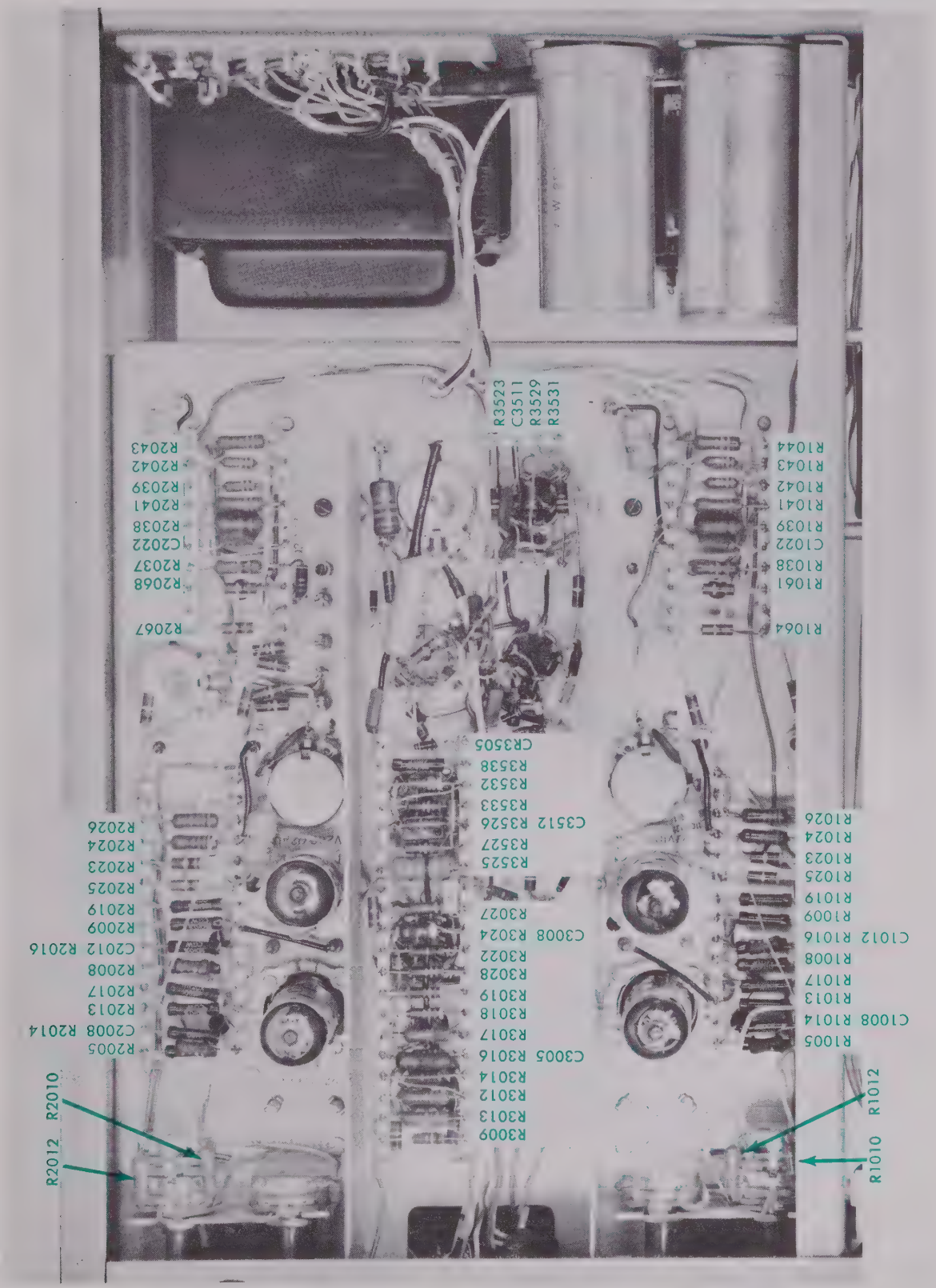


Figure 5-3b. Identification of Replaceable Components

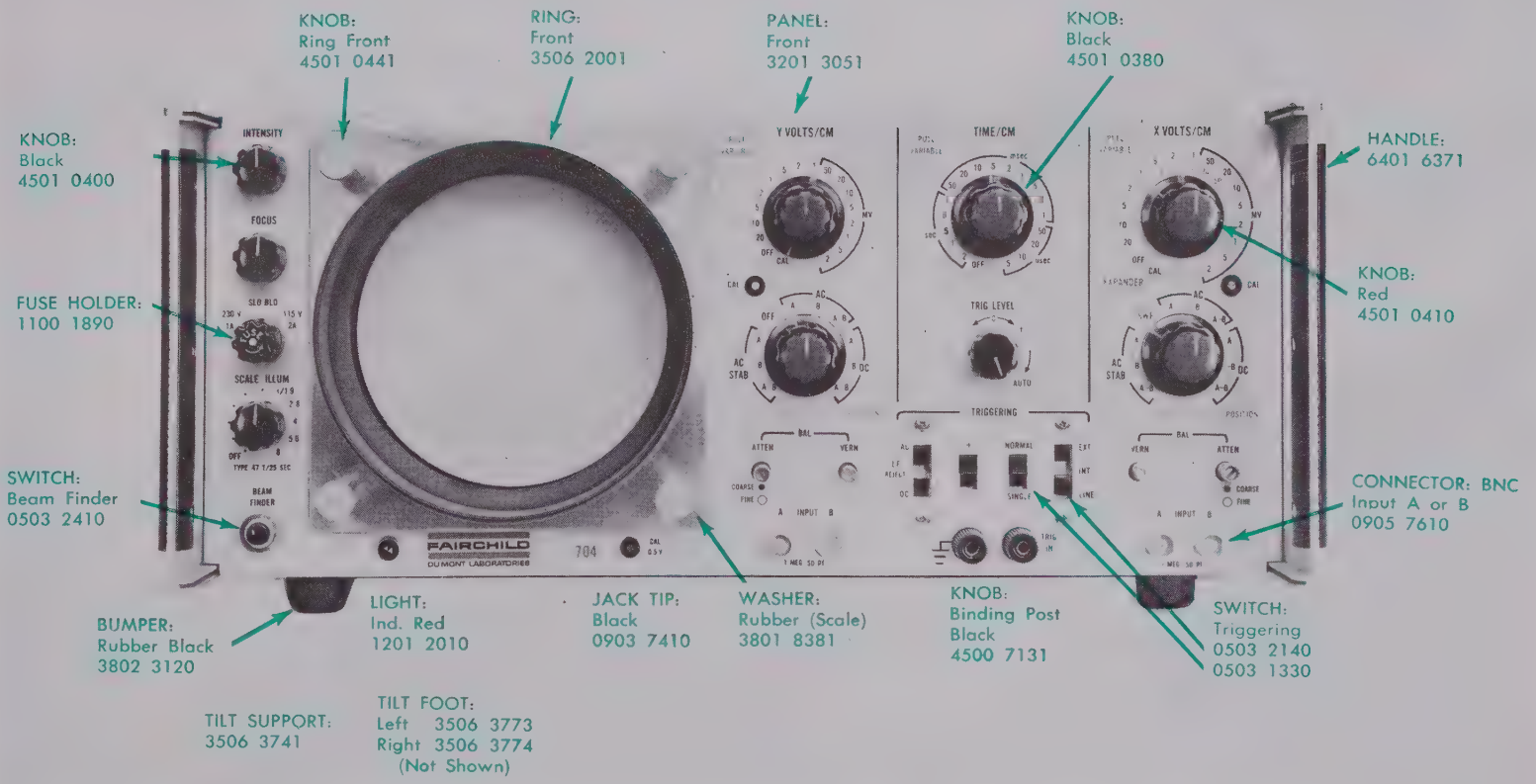


Figure 6-1. Identification of Replaceable Parts

SECTION 6A
ELECTRICAL PARTS LIST AND SCHEMATICS

TYPE 704 OSCILLOSCOPE

Symbol	Part Number	Description	Recommended Vendor Code	Type
		CAPACITORS (1000)		
		Notes: 1. All capacitors are fixed, ceramic, and 500V unless otherwise specified; pf denotes picofarads. 2. GMV denotes Guaranteed Minimum Value.		
C1001 & C1002	0326 5710	plastic, 0.1 µf, ±20%, 600V	GUD	No. 355F
C1003 & C1004	0319 1252	variable, plastic, 0.65-3 pf, 300V	ABD	
C1005	0319 1060	0.01 µf, +60 −40%, 150V	CRL	DDM
C1006	0315 6990	10 pf, ±1%, 1000V	RMC	C
C1007	0319 1060	0.01 µf, +60 −40%, 150V	CRL	DDM
C1008	0316 7230	6.2 pf, ±0.25 pf	ERC	NPO-331
C1009	0315 6990	10 pf, ±1 pf, 1000V	RMC	C
C1010	0327 1690	electrolytic, 250 pf, +150 −10%, 6V	CDE	BR
C1011	0315 6990	10 pf, ±1 pf, 1000V	RMC	C
C1012	0316 7230	6.2 pf, ±0.25 pf	ERC	NPO-331
C1013	0326 4640	0.01 µf, GMV	ERC	811
C1014	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C1015	0326 4640	0.1 µf, GMV	ERC	811
C1016	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C1017 & C1018	0316 7220	5.6 pf, ±0.25 pf	ERC	NPO-331
C1019	0305 5320	mica, 430 pf, ±5%, 300V	EIA	
C1020	0318 7040	1.8 pf, ±0.25 pf	ERC	NPO-331
C1021 & C1022	0326 4640	0.01 µf, GMV	ERC	811
C1023 & C1024	0316 7250	7.5 pf, ±0.25 pf	ERC	NPO-331
C1026	0316 7250	7.5 pf, ±0.25 pf	ERC	NPO-331
C1027	0318 7040	1.8 pf, ±0.25 pf	ERC	NPO-331
C1101	0313 4290	21 pf, ±0.5 pf	ERC	GP1K
C1102	0317 7040	mica, 470 pf, ±10%	EMC	DM20
C1103 & C1104	0326 8650	variable, 4-30 pf	ERC	TS2A-503-001
C1105	0313 6250	mica, 187 pf, ±2%, 300V	EMC	605
C1106	0313 4290	21 pf, ±0.5 pf	ERC	GP1K
C1107	0317 7040	mica, 470 pf, ±10%	EMC	DM20
C1108 & C1109	0326 8650	variable, 4-30 pf	ERC	TS2A-503-001
C1111	0313 6250	mica, 187 pf, ±2%, 300V	EMC	605
		CAPACITORS (2000)		
C2001 & C2002	0326 5710	plastic, 0.1 µf, ±10%, 600V	GUD	355F
C2003 & C2004	0319 1263	variable, plastic, 0.65-3 pf, 300V	ABD	
C2005	0326 4640	0.01 µf, GMV	ERC	811
C2006	0315 6990	10 pf, ±1 pf, 1000V	RMC	C
C2007	0326 4640	0.01 µf, GMV	ERC	811
C2008	0316 7230	6.2 pf, ±0.25 pf	ERC	NPO-331
C2009	0315 6990	10 pf, ±1 pf, 1000V	RMC	C
C2010	0327 1690	electrolytic, 250µf, +150 −10%, 6V	CDE	BR
C2011	0315 6990	10 pf, ±1 pf, 1000V	RMC	C
C2012	0316 7230	6.2 pf, ±0.25 pf	ERC	NPO-331
C2013	0326 4640	0.01 µf, GMV	ERC	811
C2014	0316 7160	3.3 pf, ±0.25 pf	ERC	NPO-331
C2015	0326 4640	0.01 µf, GMV	ERC	811
C2016	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C2017 & C2018	0316 7220	5.6 pf, ±0.25 pf	ERC	NPO-331
C2019	0305 5320	mica, 430 pf, ±5%, 300V	EIA	
C2020	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C2021 & C2022	0326 4640	0.01 µf, GMV	ERC	811
C2023	0300 7790	variable, 1.5-7 pf	ERC	NPO-TS2A
C2101	0313 4290	21 pf, ±0.5 pf	ERC	GP1K
C2102	0317 7040	mica, 470 pf, ±10%	EMC	DM20
C2103 & C2104	0326 8650	variable, 4-30 pf	ERC	TS2A-503-001
C2105	0313 6250	mica, 187 pf, ±2%, 300V	EMC	605
C2106	0313 4290	21 pf, ±0.5 pf	ERC	GP1K
C2107	0317 7040	mica, 470 pf, ±10%	EMC	DM20
C2108 & C2109	0326 8650	variable, 4-30 pf	ERC	TS2A-503-001
C2111	0313 6250	mica, 187 pf, ±2%, 300V	EMC	605
		CAPACITORS (3000)		
C3001	0326 4520	1000 pf, GMV	ERC	831
C3002	0326 4550	2000 pf, GMV	ERC	831
C3003	0315 2000	100 pf, ±20%	EIA	
C3004	0326 4640	0.01 µf, GMV	ERC	811
C3005	0319 5850	27 pf, ±5%	ERC	NPO-332
C3006	0326 4640	0.01 µf, GMV	ERC	811
C3007	0326 7840	plastic, 0.047 µf, ±10%, 125V	AMX	C296AA—
C3008	0315 2970	39 pf, ±10%	ERC	GPSL-331
C3009	0316 7470	47 pf, ±5%	ERC	NPO-331
C3501	0326 8650	variable, 4-30 pf	ERC	TS2A-503-001
C3502	0314 2660	68 pf, ±5%	ERC	GP1-331
C3503	0326 8760	plastic, 0.86 µf, ±1%, 100V	GUD	355B
C3504	0318 5370	mica, 8514 pf, ±1%	EMC	CM35D
C3505	0319 9830	plastic, 0.0047 µf, ±20%, 400V	GUD	355E
C3506	0326 7900	plastic, 0.47 µf, ±10%, 125V	AMX	C296AA—
C3507	0316 6630	390 pf, ±10%	ERC	GP2-331
C3508	0326 4640	0.01 µf, GMV	ERC	811
C3509	0305 5450	mica, 32 pf, ±5%	EIA	
C3511	0326 4640	0.01 µf, GMV	ERC	811
C3512 & C3513	0305 5100	mica, 51 pf, ±5%	EIA	
C3514	0326 8060	plastic, 0.1 µf, ±10%, 400V	AMX	C296AA—
		CAPACITORS (4000)		
C4000	0326 4640	0.01 µf, GMV	ERC	811
C4001	0327 1940	electrolytic, 100 µf, +100 −10%, 400V	MAL	FP
C4002	0326 4640	0.01 µf, GMV	ERC	811
C4003	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C4004	0300 2440	electrolytic, 10 µf, +50 −10%, 450V	CDE	UP-1045

section 6 – parts list and schematics

Symbol	Part Number	Description	Recommended Vendor Code	Type
C4005	0319 4460	electrolytic, 150 µf, +100 —10%, 300V	MAL	FP
C4006	0326 7590	electrolytic, 12 µf, +100 —10%, 150V	SPG	Series TE "Littl-Lytic"
C4007	0316 3420	electrolytic, 1000 µf, +40 —10%, 30V	SPG	DFP
C4008	0326 4640	0.01 µf, GMV	ERC	811
C4009	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C4010	0326 4640	0.01 µf, GMV	ERC	811
C4011	0314 3250	electrolytic, 100 µf, +250 —10%, 25V	CDE	BBR
C4012 & C4013	0319 1060	0.01 µf, +60 —40%, 150V	CRL	DDM
C4014	0326 4640	0.01 µf, GMV	ERC	811
C4015	0316 3420	electrolytic, 1000 µf, +40 —10%, 30V	SPG	DFP
C4016	0326 4640	0.01 µf, GMV	ERC	811
C4502	0316 9190	paper, 1000 pf, ±20%, 3000V	RMC	3 KV
C4503 & C4504	0326 4640	0.01 µf, GMV	ERC	811
C4505	0326 7860	plastic, 0.1 µf, ±10%, 125V	AMX	C296AA—
C4506	0327 1910	3300 pf, +80 —20%, 4000V	CRL	CJ
C4507 & C4508	0326 4640	0.01 µf, GMV	ERC	811
C4509	0312 9300	mica, 1000 pf, ±5%	EMC	603M
C4510	0326 8060	plastic, 0.1 µf, ±10%, 400V	AMX	C296AA
C4511	0316 8790	mica, 510 pf, ±20%, 1000V	EMC	VCM-20-B
C4513	0326 4640	0.01 µf, GMV	ERC	811
C4514 & C4515	0317 2920	electrolytic, 12 µf, +100 —0%, 350V	CDE	BR1235
C4516 & C4517	0327 1910	3300 pf, +80 —20%, 4000V	CRL	CJ
C4518	0326 4660	0.02 µf, GMV	ERC	841

SEMICONDUCTORS

CR3501 to C43506	2600 6910	diode, FD841	FCI	
CR4001 to CR4006	2600 7930	diode, silicon, CER 70	SOL	CER 70
CR4007 & CR4008	2600 7910	diode, silicon, HC 67	SOL	HC 67

LAMPS

E3501	1200 3960	glow, NE-2	GE	NE-2
DS4001	1201 1280	incandescent, 6.3V, GE #12	GE	No. 12
DS4002 & DS4003	1200 1310	incandescent, bayonet, 6.3V, #47	GE	No. 47

FUSES

F410	1100 0990	2 amperes, slow blow	LFI	313002
F410	1100 0960	1 ampere, slow blow	LFI	313002

ELECTRICAL CONNECTORS

J1001 & J2001	0905 7610	receptacle, RF, BNC, female, 1 contact (INPUT A)		UG-625A/U
J2001 & J2002	0905 7610	receptacle, RF, BNC, female, 1 contact, (INPUT B)		UG-625A/U
J3001	5101 2551	binding post (EXT TRIG)	ABD	
J3002	5101 2553	binding post (EXT TRIG GND)	ABD	
J4001	0903 7410	jack tip, black (CAL 0.5V p-p)	UCN	No. 118930
J4002	0904 4234	receptacle, AC, modified	ABD	

TRANSISTORS

Q1001 & Q1002	2600 7420	DU #9A	FCI	
	2600 7400	alternate 2N869		
Q1003 & Q1004	2600 7070	DU #2A	FCI	
	2600 7050	alternate 2N915		
Q1005 & Q1006	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q2001 & Q2002	2600 7420	DU #9A	FCI	
	2600 7400	alternate 2N869		
Q2003 & Q2004	2600 7070	DU #2A	FCI	
	2600 7050	alternate 2N915		
Q2005 & Q2006	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q4001	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q4004	2600 7230	DU #5B	FCI	
	2600 7200	alternate 2N697		
Q4005	2600 8010	2N1378	TEX	
Q4006	2600 7820	2N1529	MOT	
	2600 8030	alternate 2N511		
Q4007	2600 7210	DU #5	FCI	
	2600 7200	alternate 2N697		

RESISTORS (1000)

Note: All resistors are fixed, film, ±5%, ½W, and values in ohms unless otherwise specified; K = thousand, M = million.

R1001	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R1002	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R1003	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R1004	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R1005	0236 7740	140K, ±1%	CGW	N20
R1006 & R1007	0236 6900	18.7K, ±1%	CGW	N20
R1008	0236 7740	140K, ±1%	CGW	N20
R1009	0236 7770	150K, ±1%	CGW	N20
R1010	0234 9450	47K, 1W	CGW	C-32
R1011 F, R	0109 1610	variable, wire wound, 10K/10K, ±10%, 4W (FINE/COARSE)	CTS	C2-AW
R1012	0234 9450	47K, 1W	CGW	C-32
R1013	0236 7770	150K, ±1%		
R1014	0236 6930	20K, ±1%	CGW	N20
R1015	0109 1660	variable, wire wound, 5K, ±10% (VERN BAL)	CTS	AW
R1016	0236 6930	20K, ±1%	CGW	N20
R1017	0236 7620	105K, ±1%	CGW	N20
R1019	0236 7620	105K, ±1%	CGW	N20
R1021 & R1022	0203 1650	composition, 100, ±10%	ALB	EB
R1023	0203 1610	composition, 47, ±10%	ALB	EB
R1024	0234 9270	8.2K, 1W	CGW	C-32
R1025	0203 1610	composition, 47, ±10%	ALB	EB
R1026	0234 9270	8.2K, 1W	CGW	C-32
R1029	0203 0340	composition, 270	ALB	EB
R1031	0106 9040	variable, composition, 500, ±10% (GAIN CAL)	CTS	70
R1032 (part of S110)	0107 2366	variable, composition, 2.5K (VERNIER)	ABD	
R1033	0203 1650	composition, 100, ±10%	ALB	EB
R1036	0203 1650	composition, 100, ±10%	ALB	EB
R1037	0203 1580	composition, 27, ±10%	ALB	EB
R1038 & R1039	0234 9400	30K, 1W	CGW	C-32
R1041	0234 9350	18K, 1W	CGW	C-32
R1042 & R1043	0234 8300	2.4K	CGW	C-20
R1044	0234 9350	18K, 1W	CGW	C-32
R1046	0203 0670	composition, 6.2K	ALB	EB
R1047	0203 0860	composition, 39K	ALB	EB
R1049 F, R	0109 1110	variable, composition, 50K/50K, ±20%, 1W (POSITION)	CTS	Series 2:90CV
R1051	0203 0860	composition, 39K	ALB	EB
R1052	0203 1650	composition, 100, ±10%	ALB	EB
R1053	0203 0400	composition, 470	ALB	EB
R1054	0203 1650	composition, 100, ±10%	ALB	EB
R1055	0203 0420	composition, 560	ALB	EB

Symbol	Part Number	Description	Recommended Vendor Code	Type
R1056 & R1057	0239 1402	16K, 2W	ABD	
R1059	0108 4680	variable, composition, 5K, ±20%, 1W (OUTPUT LEVEL ADJ)	CTS	#90CV
R1060	0203 1890	composition, 10K, ±10%	ALB	EB
R1061	0203 1580	composition, 27, ±10%	ALB	EB
R1062 & R1063	0236 9790	7.5K, ±2%, 2W	CGW	C42S
R1064	0203 1580	composition, 27, ±10%	ALB	EB
R1066	0203 1220	composition, 1.2M	ALB	EB
R1067	0203 1050	composition, 240K	ALB	EB
R1068	0203 1130	composition, 510K	ALB	EB
R1101	0236 5680	1K, ±1%	CGW	N20
R1102	0236 8950	10.1K, ±1%	CGW	N20
R1103	0204 1440	10M	IRC	GBT1/2
R1104	0236 8960	111K, ±1%	CGW	N20
R1105	0236 5680	1K, ±1%	CGW	N20
R1106	0236 8950	10.1K, ±1%	CGW	N20
R1107	0204 1440	10M	IRC	GBT1/2
R1108	0236 8960	111K, ±1%	CGW	N20
R1109	0236 8970	18.1K, ±1%	CGW	N20
R1110	0229 4990	1M, ±1%	ELC	DC1/2B
R1111	0236 8980	990, ±1%	CGW	N20
R1113	0229 4990	1M, ±1%	ELC	DC1/2B
R1114	0236 4960	178, ±1%	CGW	N20
R1115	0236 8990	9K, ±1%	CGW	N20
R1116	0236 9000	2.25K, ±1%	CGW	N20
R1118	0236 8940	468, ±1%	CGW	N20

RESISTORS (2000)

R2001	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R2002	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R2003	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R2004	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R2005	0236 7740	140K, ±1%	CGW	N20
R2006 & R2007	0236 6900	18.7K, ±1%	CGW	N20
R2008	0236 7740	140K, ±1%	CGW	N20
R2009	0236 7770	150K, ±1%	CGW	N20
R2010	0234 9450	47K, 1W	CGW	C-32
R2011 F, R	0109 1610	variable, wire wound, 10K/10K, ±10% (FINE/COARSE)	CTS	C2-AW
R2012	0234 9450	47K, 1W	CGW	C-32
R2013	0236 7770	150K, ±1%	CGW	N20
R2014	0236 6930	20K, ±1%	CGW	N20
R2015	0109 1660	variable, wire wound, 5K, ±10% (VERN BAL)	CTS	AW
R2016	0236 6930	20K, ±1%	CGW	N20
R2017	0236 7620	105K, ±1%	CGW	N20
R2019	0236 7620	105K, ±1%	CGW	N20
R2021 & R2022	0203 1650	composition, 100, ±10%	ALB	EB
R2023	0203 1610	composition, 47, ±10%	ALB	EB
R2024	0234 9270	8.2K, 1W	CGW	C-32
R2025	0203 1610	composition, 47, ±10%	ALB	EB
R2026	0234 9270	8.2K, 1W	CGW	C-32
R2028	0203 0340	composition, 270	CGW	N20
R2029	0106 9040	variable, composition, 500, ±10% (GAIN CAL)	CTS	70
R2031 (part of S210)	0107 2366	variable, composition, 2.5K, ±20% (VERNIER)	ABD	
R2032	0203 1650	composition, 100, ±10%	ALB	EB
R2034	0203 1650	composition, 100, ±10%	ALB	EB
R2036	0203 1580	composition, 27, ±10%	ALB	EB
R2037 & R2038	0234 9400	30K, 1W	CGW	C-32
R2039	0234 8300	2.4K	CGW	C-20
R2040	0229 4710	1.5M, ±1%	TEX	CD1/2PR
R2041	0234 9350	18K, 1W	CGW	C-32
R2042	0234 8300	2.4K	CGW	C-20
R2043	0234 9350	18K, 1W	CGW	C-32
R2044	0203 0670	composition, 6.2K	ALB	EB
R2045	0236 7770	150K, ±1%	CGW	N20
R2046	0203 0860	composition, 39K	ALB	EB
R2047	0109 1270	variable, composition, 50K/50K, ±10%, 2W (POSITION)	CTS	Series 2:90CV
R2048	0203 0860	composition, 39K	ALB	EB
R2049	0203 1650	composition, 100, ±10%	ALB	EB
R2052	0203 1650	composition, 100, ±10%	ALB	EB
R2053 & R2054	0203 1000	composition, 150K	ALB	EB
R2056	0203 0930	composition, 75K	ALB	EB
R2057	0109 1340	variable, composition, 100K, ±30%, ¼W (SWP EXP BAL)	CTS	Series 45
R2058	0203 0930	composition, 75K	ALB	EB
R2061	0203 0420	composition, 560	ALB	EB
R2062 & R2063	0239 1402	16K, 2W	ABD	
R2064	0203 0400	composition, 470	ALB	EB
R2066	0108 4680	variable, composition, 5K, ±20%, 1W (OUTPUT LEVEL ADJ)	CTS	90CV
R2067 & R2068	0203 1580	composition, 27, ±10%	ALB	EB
R2069	0236 9790	7.5K, ±2%, 2W	CGW	C42S
R2071	0236 9790	7.5K, ±2%, 2W	CGW	C42S
R2101	0236 5680	1K, ±1%	CGW	N20
R2102	0236 8950	10.1K, ±1%	CGW	N20
R2103	0204 1440	composition, 10M	IRC	GBT1/2
R2104	0236 8960	111K, ±1%	CGW	N20
R2105	0236 5680	1K, ±1%	CGW	N20
R2106	0236 8950	10.1K, ±1%	CGW	N20
R2107	0204 1440	composition, 10M	IRC	GBT1/2
R2108	0236 8960	111K, ±1%	CGW	N20
R2109	0236 8970	18.1K, ±1%	CGW	N20
R2110	0229 4990	1M, ±1%	ELC	DC1/2B
R2111	0236 8980	990, ±1%	CGW	N20
R2113	0229 4990	1M, ±1%	ELC	DC1/2B
R2114	0236 4960	178, ±1%	CGW	N20
R2115	0236 8990	9K, ±1%	CGW	N20
R2116	0236 9000	2.25K, ±1%	CGW	N20
R2118	0236 8940	468, ±1%	CGW	N20

RESISTORS (3000)

R3001	0203 1890	composition, 10K, ±10%	ALB	EB
R3002	0203 0960	composition, 100K	ALB	EB
R3003	0203 1200	composition, 1M	ALB	EB
R3004	0203 1040	composition, 220K	ALB	EB
R3005	0203 1000	composition, 150K	ALB	EB
R3006 (part of S313)	0107 2741	variable, composition, 500K, ¼W (TRIG LEVEL)	ABD	
R3007	0203 0890	composition, 51K	ALB	EB
R3008	0203 1650	composition, 100, ±10%	ALB	EB
R3009	0203 0720	composition, 10K	ALB	EB
R3010	0203 0930	composition, 75K	ALB	EB
R3011	0203 1650	composition, 100, ±10%	ALB	EB
R3012	0234 9260	7.5K, 1W	CGW	C-32
R3013	0234 9470	56K, 1W	CGW	C-32
R3014	0203 0690	composition, 7.5K	ALB	EB
R3015 & R3016	0234 8540	24K	CGW	C-20
R3017	0234 9490	68K, 1W	CGW	C-32
R3018 & R3019	0203 0880	composition, 47K	ALB	EB
R3021	0203 1650	composition, 100, ±10%	ALB	EB
R3022	0203 1270	composition, 2M	ALB	EB
R3023	0203 0540	composition, 1.8K	ALB	EB
R3024	0236 7740	140K, ±1%	CGW	N20
R3025	0236 7770	150K, ±1%	CGW	N20
R3026	0203 1650	composition, 100, ±10%	ALB	EB
R3027	0203 0600	composition, 3.3K	ALB	EB
R3028	0203 0780	composition, 18K	ALB	EB
R3501 (part of S350)	0107 2361	variable, composition (VERNIER)	ABD	
R3502	0109 1320	variable, composition, 2K (SWP CAL)	CTS	Series 45
R3503	0203 0780	composition, 18K	ALB	EB
R3504 to R3506	0234 2270	10M, ±1%	TEX	CD1/2SR

Symbol	Part Number	Description	Recommended Vendor Code	Type
R3507	0234 2260	6M, ±1%	TEX	CD1/2SR
R3508	0229 4680	2M, ±1%	TEX	CD1/2PR
R3509	0229 4990	1M, ±1%	ELC	DC1/2B
R3511	0224 4990	1M, ±1%	ELC	DC1/2B
R3512	0203 0550	composition, 2K	ALB	EB
R3516	0203 1040	composition, 220K	ALB	EB
R3518	0236 7210	39.2K, ±1%	CGW	N20
R3519	0203 1650	composition, 100, ±10%	ALB	EB
R3521	0236 7330	52.3K, ±1%	CGW	N20
R3522	0236 7480	75K, ±1%	CGW	C20
R3523	0203 1000	composition, 150K	ALB	EB
R3525	0239 1408	30K, 2W	CGW	C-42
R3526 & R3527	0203 0890	composition, 51K	ALB	EB
R3528	0203 0900	composition, 56K	ALB	EB
R3529	0203 0960	composition, 100K	ALB	EB
R3531	0203 1080	composition, 330K	ALB	EB
R3532	0203 0870	composition, 43K	ALB	EB
R3533	0203 0930	composition, 75K	ALB	EB
R3534	0203 1650	composition, 100, ±10%	ALB	EB
R3535	0234 9160	3K, 1W	CGW	C-32
R3536	0109 1310	variable, composition, 1.5K (LENGTH)	CTS	Series 45
R3537	0239 1389	5.6K, 2W	CGW	C-42
R3538	0236 7440	68.1K, ±1%	CGW	N20
R3539	0234 9440	43K, 1W	CGW	C-32
R3540	0203 1610	composition, 47, ±10%	ALB	EB
R3541	0203 1650	composition, 100, ±10%	ALB	EB
R3542	0203 0540	composition, 1.8K	ALB	EB
R3543	0234 9420	36K, 1W	CGW	C-32
R3544	0203 0770	composition, 16K	ALB	EB
R3545	0203 0870	composition, 43K	ALB	EB
R3546	0203 1440	composition, 10M	ALB	EB
R3547	0203 2130	composition, 1M, ±10%	ALB	EB

RESISTORS (4000)

R4000	0239 1491	100K, ±10%, 2W	CGW	C-42
R4001	0203 1280	composition, 2.2M	ALB	EB
R4002	0203 0820	composition, 27K	ALB	EB
R4004	0203 1770	composition, 1K, ±10%	ALB	EB
R4005 & R4006	0203 0070	composition, 20	ALB	EB
R4007	0234 8540	24K	CGW	C-20
R4008 F, R	0109 1560	variable, wire wound, 10K/10K, ±10% (+59/+160 ADJ)	CTS	C2-AW
R4009	0234 8620	51K	CGW	C-20
R4010	0203 1770	composition, 1K, ±10%	ALB	EB
R4011	0239 1392	6.8K, 2W	ABD	
R4012	0203 1790	composition, 1.5K, ±10%	ALB	EB
R4013	0203 1270	composition, 2M	ALB	EB
R4014	0203 1800	composition, 1.8K, ±10%	ALB	EB
R4015	0203 1340	composition, 3.9M	ALB	EB
R4016	0203 2040	composition, 180K, ±10%	ALB	EB
R4017	0203 1120	composition, 470K	ALB	EB
R4018	0203 0720	composition, 10K	ALB	EB
R4019	0236 7740	140K, ±1%	CGW	C-20
R4021	0236 7260	44.2K, ±1%	CGW	N20
R4022	0236 5990	2.1K, ±1%	CGW	N20
R4023	0236 6470	6.65K, ±1%	CGW	N20
R4024	0203 1010	composition, 160K	ALB	EB
R4025	0203 1820	composition, 2.7K, ±10%	ALB	EB
R4026	0203 1770	composition, 1K, ±10%	ALB	EB
R4027	0239 1455	220, ±10%, 2W	ABD	
R4028	0203 1850	composition, 4.7K, ±10%	ALB	EB
R4029	0203 1770	composition, 1K, ±10%	ALB	EB
R4031	0203 1770	composition, 1K, ±10%	ALB	EB
R4032	0107 2344	variable, wire wound, 50, ±10%, 2W (SCALE)	ABD	
R4033	0203 1770	composition, 1K, ±10%	ALB	EB
R4034	0203 2130	composition, 1M, ±10%	ALB	EB
R4035	0234 8630	56K	CGW	C-20
R4036	0234 8610	47K	CGW	C-20
R4037	0234 9290	10K, 1W	CGW	C-32

Symbol	Part Number	Description	Recommended Vendor Code	Type
R4050	0203 1850	composition, 4.7K, ±10%	ALB	EB
R4051	0239 1406	24K, 2W	CGW	C-42
R4052	0203 0930	composition, 75K	ALB	EB
R4053	0236 7740	140K, ±1%	CGW	N20
R4054	0236 6910	19.1K, ±1%	CGW	N20
R4055	0236 5390	499, ±1%	CGW	N20
R4056	0236 4430	49.9, ±1%	CGW	N20
R4057	0239 1406	24K, 2W	CGW	C-42
R4058	0203 1850	composition, 4.7K, ±10%	ALB	EB
R4059	0203 0640	composition, 4.7K	ALB	EB
R4300	0236 9020	wire wound, 2K, 20W	TRU	MOR-20
R4502	0229 8150	11M, 2W	TEX	CD2R
R4503	0108 0760	variable, composition, 2.5M (FOCUS)	CLS	Series 37
R4504	0203 2140	composition, 1.2M, ±10%	ALB	EB
R4505	0109 1340	variable, composition, 100K, ¼W (HV ADJ)	CTS	45
R4506	0229 8160	16.2M, 2W	TEX	CD2R
R4507	0236 3240	1.21M, ±1%	TEX	CD1/2PR
R4508	0203 1610	composition, 47, ±10%	ALB	EB
R4509	0109 0080	variable, composition, 500K, ±20%, 1W (INTENSITY)	CLS	Series 53C
R4511	0203 1020	composition, 180K	ALB	EB
R4512	0203 1120	composition, 470K	ALB	EB
R4513	0234 8580	36K	CGW	C-20
R4515	0234 8690	100K	CGW	C-20
R4516	0203 2150	composition, 1.5M, ±10%	ALB	EB
R4517	0203 1610	composition, 47, ±10%	ALB	EB
R4518	0203 1030	composition, 200K	ALB	EB
R4519	0203 1610	composition, 47, ±10%	ALB	EB
R4520	0203 1690	composition, 220, ±10%	ALB	EB
R4521	0228 3980	7.5K, 3W	CGW	LP13
R4522	0203 2130	composition, 1M, ±10%	ALB	EB
R4523	0109 1340	variable, composition, 100K, ¼W (ASTIG)	CTS	45
R4524	0203 0870	composition, 43K	ALB	EB
R4525	0203 0820	composition, 27K	ALB	EB
R4526	0234 8560	30K	CGW	C-20
R4527	0234 8520	20K	CGW	C-20
R4528	0236 7100	30.1K, ±1%	CGW	N20
R4529	0236 6930	20K, ±1%	CGW	N20
R4531 & R4532	0203 1670	composition, 150, ±10%	ALB	EB
R4533	0234 8520	20K	CGW	C-20

SWITCHES

S101	0501 7051	rotary, 10 positions, 3 sections (Y INPUT SELECTOR)	ABD	
S102	0503 2410	push-push, SPST, 0.5 ampere, 115 volts ac (BEAM FINDER)	GRY	#4002
S103 (part of R1032)	0107 2366	SPDT, 3 amperes, 125 volts (VERNIER)	ABD	
S110	0501 7041	rotary, 18 positions, 6 sections (Y VOLTS/CM)	ABD	
S201	0501 7012	rotary, 10 positions, 5 sections (X INPUT SELECTOR)	ABD	
S203 (part of R2031)	0107 2366	SPDT, 3 amperes, 125 volts (PULL VERNIER)	ABD	
S210	0501 7040	rotary, 18 positions, 6 sections (X VOLTS/CM)	ABD	
S310	0503 2140	slide, DP3T, 0.5 ampere, 125 volts ac, dc, 3 positions (TRIG SOURCE)	MUT	No. 5608
S311	0503 2140	slide, DP3T, 0.5 ampere, 125 volts ac, dc, 3 positions (TRIG COUPLING)	MUT	No. 5608
S312	0503 1330	slide, DPDT (TRIG SLOPE)	STC	SS-50
S313 (part of R3006)	0107 2741	phenolic, 2 positions, 1 section, ¼W (AUTO)	ABD	
S350	0501 7032	rotary, 19 positions, 3 sections (TIME/CM)	ABD	

Symbol	Part Number	Description	Recommended Vendor Code	Type
S351 (part of R3501)	0107 2361	SPDT, 3 amperes, 125 volts	ABD	
S352	0503 1330	slide, DPDT (SINGLE/NORMAL)	STC	SS-50
S410	0503 2420	thermostatic (THERMAL CUTOUT)	EMW	2200
S411 (part of R4032)	0107 2344	DPST, 3 amperes, 125V (POWER)	ABD	

TRANSFORMERS

T4001	2001 3791	power ✓	ABD	
T4501	2001 3801	high voltage power supply ✓	ABD	

ELECTRON TUBES

V101	2501 2360	6085/E80CC	AMX	
V102	2501 1610	ECC82/12AU7	AMX	
V201	2501 2360	6085/E80CC		
V202	2501 1610	ECC82/12AU7	AMX	
V3001 & V3002	2501 2220	6DJ8/ECC88	AMX	
V3501 & V3502	2501 2220	6DJ8/ECC88	AMX	
V3503	2500 0020	6AL5	EIA	
V3504	2501 1550	6AU6A	EIA	
V4001 to V4003	2501 2400	6CW5/EL86	AMX	
V4004	2500 0810	5651	EIA	
V4005 & V4006	2501 3460	6BL8/ECF80	AMX	
V4501	2501 2400	6CW5/EL86	AMX	
V4502	2501 3460	6BL8/ECF80	AMX	
V4503	2500 5740	5642	EIA	
V4504	2501 3880*	KC2308P1	ABD	
	2501 3890*	KC2308P2-G		
	2501 3900*	KC2308P2-B		
	2501 3910*	KC2308P7		
	2501 3920*	KC2308P11		
	2501 3930*	KC2308P31		

*Depending on sales order.

CABLE

W4001	5030 1390	assembly	MIL	18/3 SJT
	0905 9000	adapter connector, 125V, 15 amperes		

LIST OF RECOMMENDED VENDORS

CODE	NAME
ABD	Allen B. Du Mont Laboratories
AER	Aerovox Corporation
AHH	Arrow-Hart & Hegeman Electric Company
ALB	Allen-Bradley Company
ALC	Allied Control
ALCO	Alco Electronics Products
ALD	Alden Products Company
AMA	Amaton Electronic Hardware
AMP	Amp Inc.
AMR	Amperite Company, Inc.
AMX	Amperex Electronic Products, Inc.
APC	American Phenolic Corporation
APH	Amphenol Electronics Corporation
ARC	Arco-Elemenco
AST	Astron Corporation
BUS	Bussman Mfg. Co.
CAN	Cannon Electric Company
CBS	CBS-Hytron Division of CBS
CGW	Corning Glass Works
CH	Cutler-Hammer, Inc.
CHC	Chester Cable Corporation
CHM	Chatham Electronics
CLS	Clarostat Mfg. Co., Inc.
CDE	Cornell-Dubilier Electric Corporation
COC	Continental Carbon
CPC	C. P. Clare & Company
CRL	Centralab, Division of Globe-Union Inc.
CST	Chicago Standard Transformer
CTC	Cambridge Thermionic Corp.
CTS	Chicago Telephone Supply Corporation
DAG	Dage Electric Company, Inc.
DAL	Dale Products, Inc.
DLC	Dialight Corporation
DRK	Drake Mfg. Co.
EBY	Hugh M. Eby, Inc.
EIA	Any manufacturer meeting EIA standards
ELC	Electra Mfg. Company
ELD	Eldema Corporation
ELM	Elmenco
EMC	Electro Motive Mfg. Company
EMW	Elmwood Sensors, Inc.
ERC	Erie Resistor Corporation
ESX	Essex Electronics
FCI	Fairchild Camera and Instrument Corporation
FER	Ferroxcube Corporation of America
GDE	Good-All Electric Mfg. Co.
GE	General Electric Company
GRC	General Radio Company
GRY	Grayhill, Inc.
GUD	The Gudeman Company
HOP	Hopkins Engineering Company
HWP	Hewlett-Packard Company
IRC	International Resistance Company
IRP	International Rectifier Corporation
ITT	ITT Components Division
JEF	Jeffers Electronics, Inc.
JHN	E. F. Johnson Company
JWM	J. W. Miller Co.
KUL	Kulka Electric Mfg. Co. Inc.
KXM	Klixon Metals and Control Corporation
LFI	Littlefuse, Inc.
MAL	P. R. Mallory & Company, Inc.
MIC	Micamold Electronics Mfg. Corporation
MIL	Miller Electric Company
MOT	Motorola Semiconductor Products, Inc.
MUC	Mucon Corporation
MUT	The Muter Company
NYT	New York Transformer Company, Inc.
OAK	Oak Mfg. Company
PHC	Philco Corporation
PHI	Philips Electronic Tube Division
PLS	Plastoid Corporation
POT	Potter & Brumfield, Inc.
PRC	Precision Resistor Co., Inc.
PYR	Pyramid Electric Company
RCA	Radio Corporation of America
RMC	Radio Materials Corporation
ROY	Royal Electric Corp., Inc.
RTN	Rotron Mfg. Company
SIG	Signalite Inc.
SLT	Sealectro Corporation
SOL	Solitron Devices, Inc.
SPG	Sprague Electric Company
STC	Stackpole Carbon Company
STW	Standard Winding Company
SUM	Summit Coil Company
SYL	Sylvania Electric Products, Inc.
SYN	Synstronic Instruments, Inc.
TEC	Transistor Electronics Corporation
TEX	Texas Instruments, Inc.
THC	Thermol Control, Inc.
TOR	Torrington Mfg. Company
TRS	Tresco, Inc.
TRU	Tru-Ohm Products
TUG	Tung-Sol Electric Inc.
UCN	Ucinite Co.
VIC	The Victoreen Instrument Company
WDL	Ward Leonard Electric Company
WES	Weston Electrical Instrument Corporation
WYN	Welwyn International Inc.

SECTION 6B
SPARE PARTS LIST

SPARE PARTS REQUIREMENTS

a. General

The type 704 Oscilloscope is an extremely reliable and dependable instrument. Only components thoroughly tested and approved by the engineers of the Quality Assurance Department are used in this instrument. Continued performance tests, environmental and life testing of production units make certain your oscilloscope will give many years of satisfactory service. These new Fairchild oscilloscopes are precision engineered and require no selected parts.

Two lists of "running spares" are included to aid you in periodic maintenance. The running-spare parts lists include recommended quantities and reference symbol numbers. Section 6A of this Instruction Manual gives a complete listing of all components and their recommended vendors so that you may readily procure them from a local supply house or your own stores.

NOTE: Your local representative and his service organization can assist you in obtaining any additional components in the shortest possible time.

b. 500-Hour Spares (6 months)

The recommended list for one through three units is given below.

Fuses

Symbol	Quantity
F410	4 each
F411	4 each

Electron Tubes

Type	Quantity
6085/E80CC	2
ECC82/12AU7	2
6DJ8/ECC88	2
6AL5	1
6AU6A	1
6CW5/EL86	1
5651	1
6BL8/ECF80	1
5642	1
KC2308P31	1

Transistors

DU #2A/2N915	2
DU #5B/2N697	1
DU #6A/2N1893	2
DU #9A/2N869	2
2N1378	1
2N1529	1

Diodes

FD841	2
Silicon diode, CER 70	1
Silicon diode, HC 67	1

Lamps

Incandescent, 6.3V, GE #12	1
Incandescent, bayonet, 63V, #47	2

c. 2000-Hour Spares (2 years)

The recommended list for one through five units is given below. Maintain spares indicated plus one for each oscilloscope in use; 2 of each set of the 500-hour spare list given in paragraph (b) plus the quantities listed as follows:

Capacitors

Symbol	Quantity	Symbol	Quantity
C1001	1	C3007	1
C1003	1	C3008	1
C1005	1	C3501	1
C1006	2	C3503	1
C1007	1	C3504	1
C1008	1	C3505	1
C1010	1	C3506	1
C1013	6	C3507	1
C1014	2	C3509	1
C1015	1	C3512	1
C1016	1	C4001	1
C1017	1	C4004	1
C1019	1	C4005	1
C1020	1	C4006	1
C1023	1	C4007	1
C1101	1	C4011	1
C1103	2	C4502	1
C1105	1	C4506	1
C1111	1	C4509	1
C2023	1	C4511	1
C3001	1	C4514	1
C3002	1	C4516	1
C3003	1	C4518	1
C3005	1		

Lamps

Symbol	Quantity
DS4001	1
DS4002	2

Electrical Connectors

J1000	2
J3001	2
J4001	1
J4002	1

Resistors

Symbol	Quantity	Symbol	Quantity
R1001	2	R1009	3
R1002	2	R1010	2
R1005	2	R1011	1
R1006	6	R1014	2

Symbol	Quantity
R1017	2
R1021	6
R1023	2
R1024	2
R1029	1
R1031	1
R1037	2
R1041	2
R1042	2
R1046	1
R1049	1
R1053	1
R1055	1
R1056	2
R1059	1
R1062	2
R1066	1
R1067	1
R1068	1
R1101	2
R1102	2
R1103	2
R1104	2
R1109	1
R1110	2
R1111	1
R1114	1
R1115	1
R1116	1
R1118	1
R2040	1
R2047	1
R2053	2
R2056	2
R3006	1
R3007	1
R3009	1
R3012	1
R3013	1
R3014	1
R3017	1
R3018	1
R3022	1
R3023	1
R3027	1
R3028	1
R3502	1
R3504	1
R3507	1
R3508	1
R3512	1
R3516	1
R3518	1
R3521	1
R3522	1
R3525	1
R3526	1
R3528	1
R3529	1

Symbol	Quantity
R3531	1
R3532	1
R3535	1
R3537	1
R3538	1
R3539	1
R3543	1
R3544	1
R3545	1
R4000	1
R4001	1
R4002	1
R4004	2
R4005	1
R4007	1
R4008	1
R4009	1
R4011	1
R4012	1
R4013	1
R4014	1
R4015	1
R4016	1
R4017	1
R4018	1
R4019	1
R4021	1
R4022	1
R4023	1
R4024	1
R4025	1
R4027	1
R4028	1
R4034	1
R4035	1
R4036	1
R4037	1
R4051	1
R4052	1
R4054	1
R4059	1
R4505	1
R4506	1
R4507	1
R4508	2
R4511	1
R4513	1
R4515	1
R4516	1
R4518	1
R4520	1
R4521	1
R4524	1
R4526	1
R4527	1
R4528	1
R4529	1
R4531	1

Transformers

Symbol	Quantity
T4001	1
T4501	1

Switches

Stock only one each of the following switches for each 3 units being maintained:

S101, S102, S110, S201, S210, S310, S350, S352, S410

NOTE: Should a particular switch receive more than normal use in certain applications (such as the BEAM FINDER) then the quantity stocked of that particular switch should be doubled.

d. Miscellaneous

The following items may be stocked in quantities of one for each 2 units being maintained:

Bumper, rubber, black	3802 3120
Fuseholder	1100 1890
Light, jewel, red	1201 2010
Knob, black	4501 0400
Knob, black	4501 0380
Knob, red	4501 0410
Knob, binding post	4500 7131
Power cord	5030 1390
Adapter connector	0905 9000

e. Summary

The quantities of spare parts given in the preceding paragraphs are intended for industrial and military duty under normal environment and heavy-use conditions. It is suggested that the maintenance engineer evaluate:

1. The conditions under which the instruments will be used.
2. The skill of the maintenance technicians.
3. Other similar items on hand.
4. The effect of procurement time of spares and effects of instrument down-time on your organization.

It is recommended that inventories of spare parts outlined above be adjusted according to the requirements of your own laboratory or plant.

In the first analysis, the factory recommends the availability of spares or standby equipments since extensive life testing of your instrument has shown no higher failure rate for any specific component.

DU MONT

INSTRUMENT WARRANTY AND SERVICE NOTICE

WARRANTY

Allen B. Du Mont Laboratories warrants that each new Cathode-ray Oscilloscope, Automotive Test Equipment, and other Electronic or Electrical Test or Measuring Equipment (hereinafter referred to as "Instrument") manufactured or sold by it, is free from defects in material or workmanship under normal use and service for a period of one year from the date of its sale to the first purchaser for use. If, upon examination by Du Mont, the Instrument is determined to be defective in workmanship or material, Du Mont will, subject to the conditions set forth below, either repair the defective part or replace it with a new part. Du Mont shall not be liable for any delay or failure to furnish a replacement part resulting directly or indirectly from any governmental restriction, priority or allocation or any other governmental regulatory order or action, nor shall Du Mont be liable for damages by reason of the failure of the Instrument to perform properly or for any consequential damages. This warranty does not apply to any Instrument that has been subject to negligence, accident, misuse or improper installation or operation or that in any way has been tampered with, altered or repaired by any person other than an authorized Du Mont service organization or an employee thereof, or to any Instrument whose serial number has been altered, defaced or removed, or to any Instrument purchased within, and thereafter removed beyond, the continental limits of the United States.

This warranty shall, at Du Mont's option, become void unless registration thereof is promptly effected as provided below. This warranty is in lieu of all other warranties, expressed or implied, and no one is authorized to assume any liability on behalf of Du Mont or impose any obligation upon it in connection with the sale of any Instrument, other than as stated above.

REGISTERING THE WARRANTY

To register this warranty, the enclosed warranty registration card must be properly filled out and mailed to the Instrument Service Department immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD. Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure service under our warranty, the enclosed warranty service card must be properly filled out and returned to the factory. In all cases where service or adjustment is requested, please first contact the factory or authorized depot, giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing to the factory in this respect, address:

ALLEN B. DU MONT LABORATORIES
Divisions of Fairchild Camera and Instrument Corporation
750 Bloomfield Avenue, Clifton, New Jersey

The Instrument Service Department will then send to the customer the written procedure for disposition and shipping instructions. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

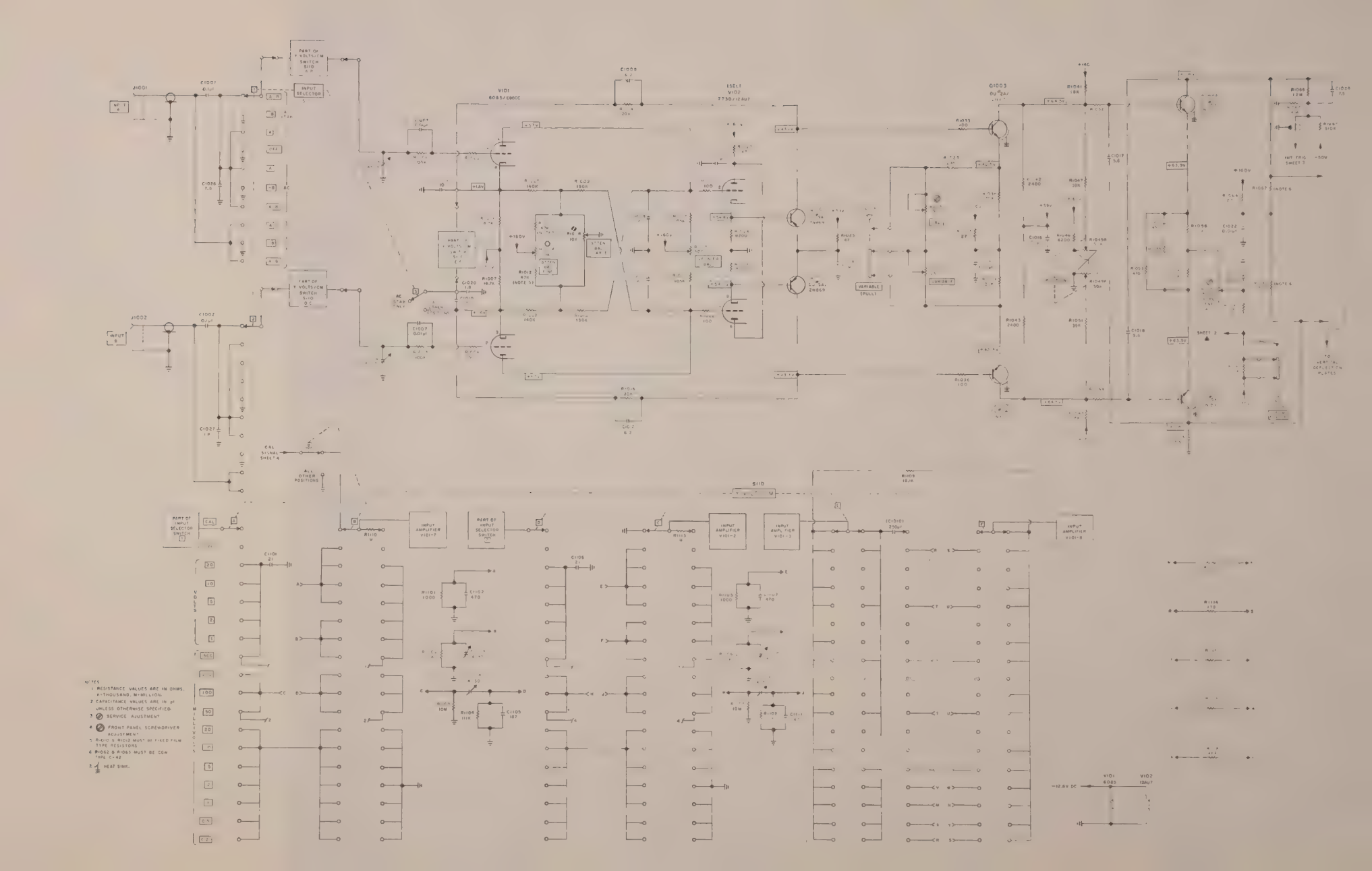
REPLACEMENT PARTS

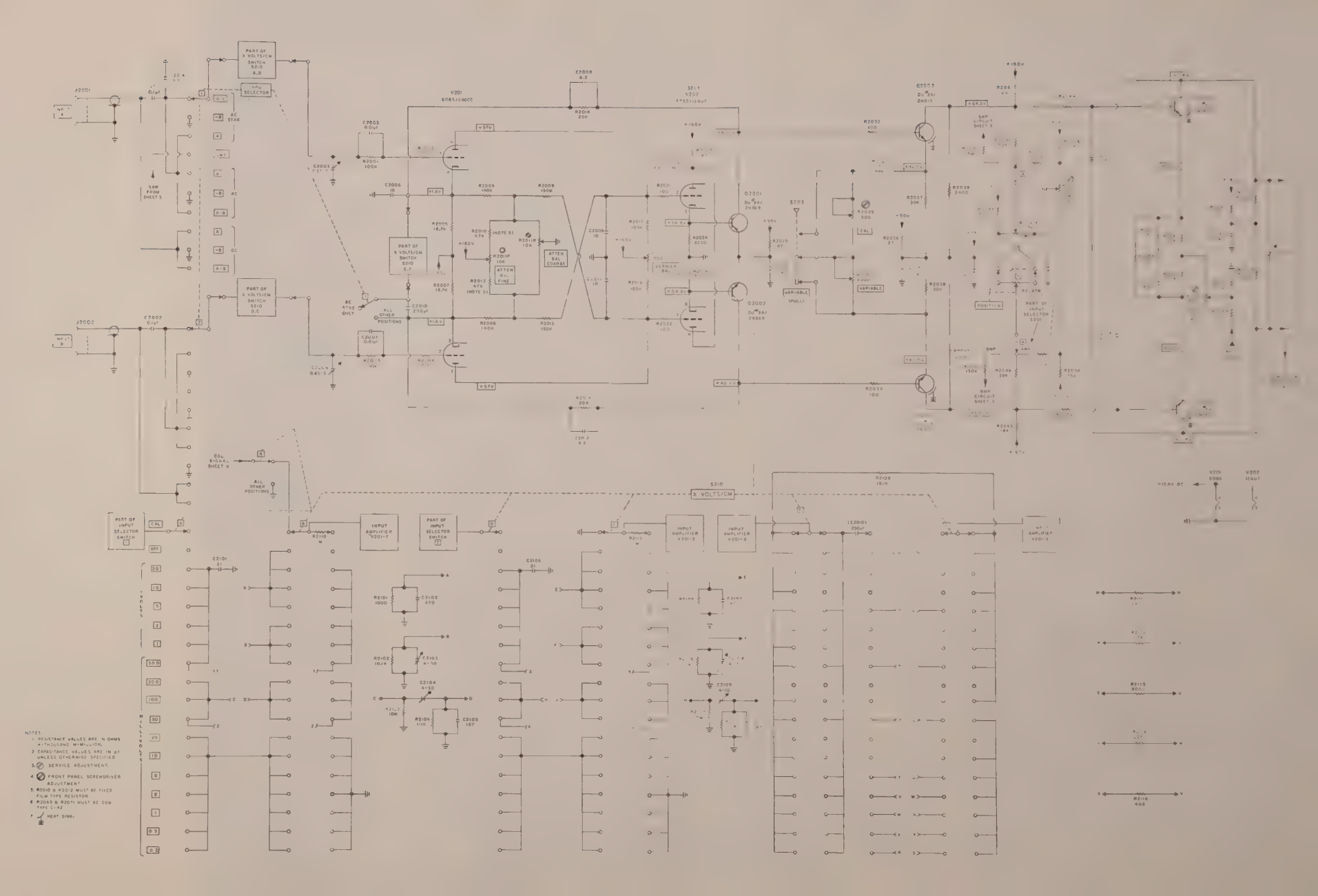
If it is necessary to order a replacement component from the factory, always give the Type number and Serial number of the Instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in the Instruction Manual. The Parts List gives the values, tolerances, ratings, and Du Mont part number for all electrical components used in the Instrument. This will help to expedite service.

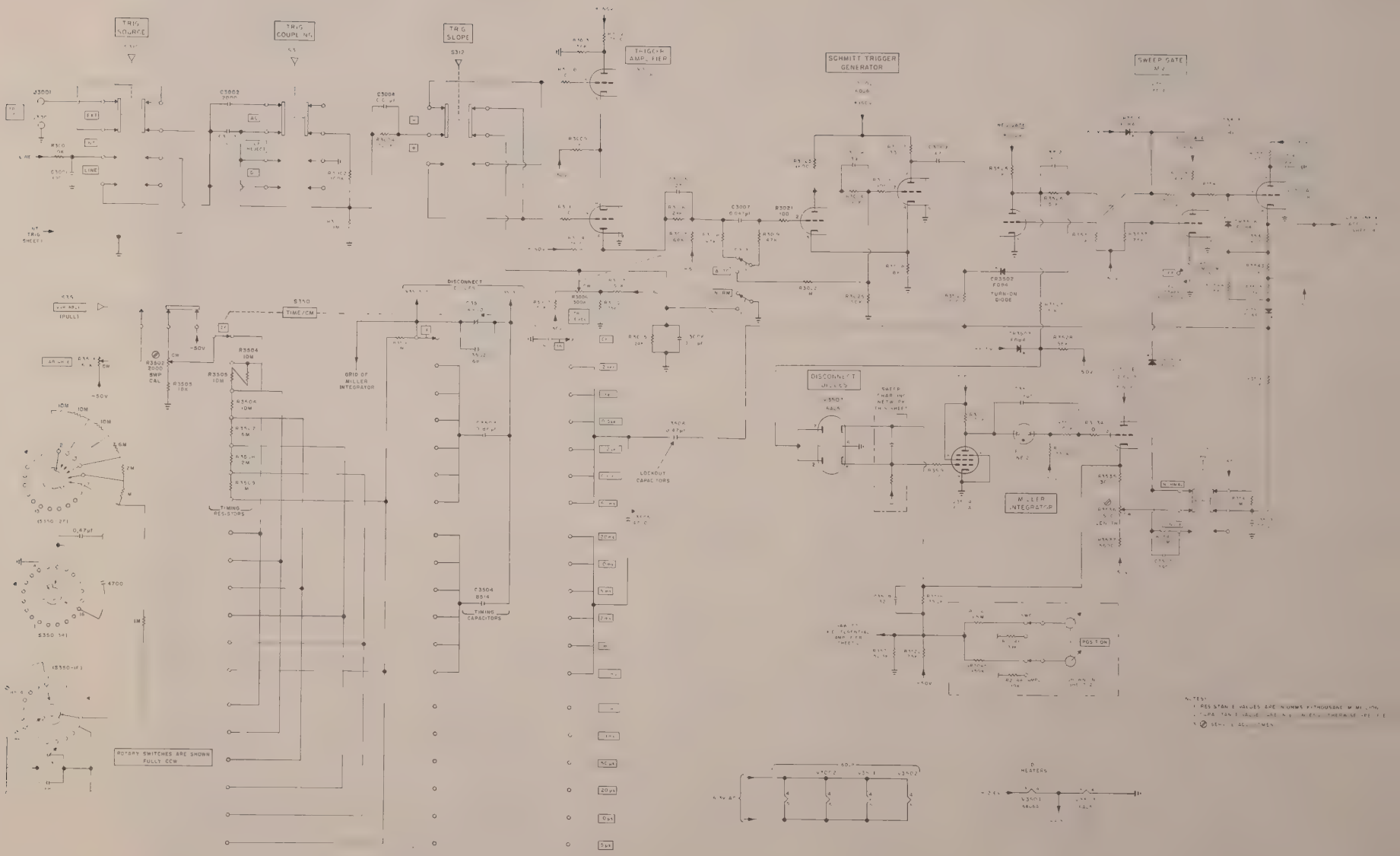
ALLEN B. DU MONT LABORATORIES
Divisions of Fairchild Camera and Instrument Corporation
750 Bloomfield Avenue, Clifton, New Jersey

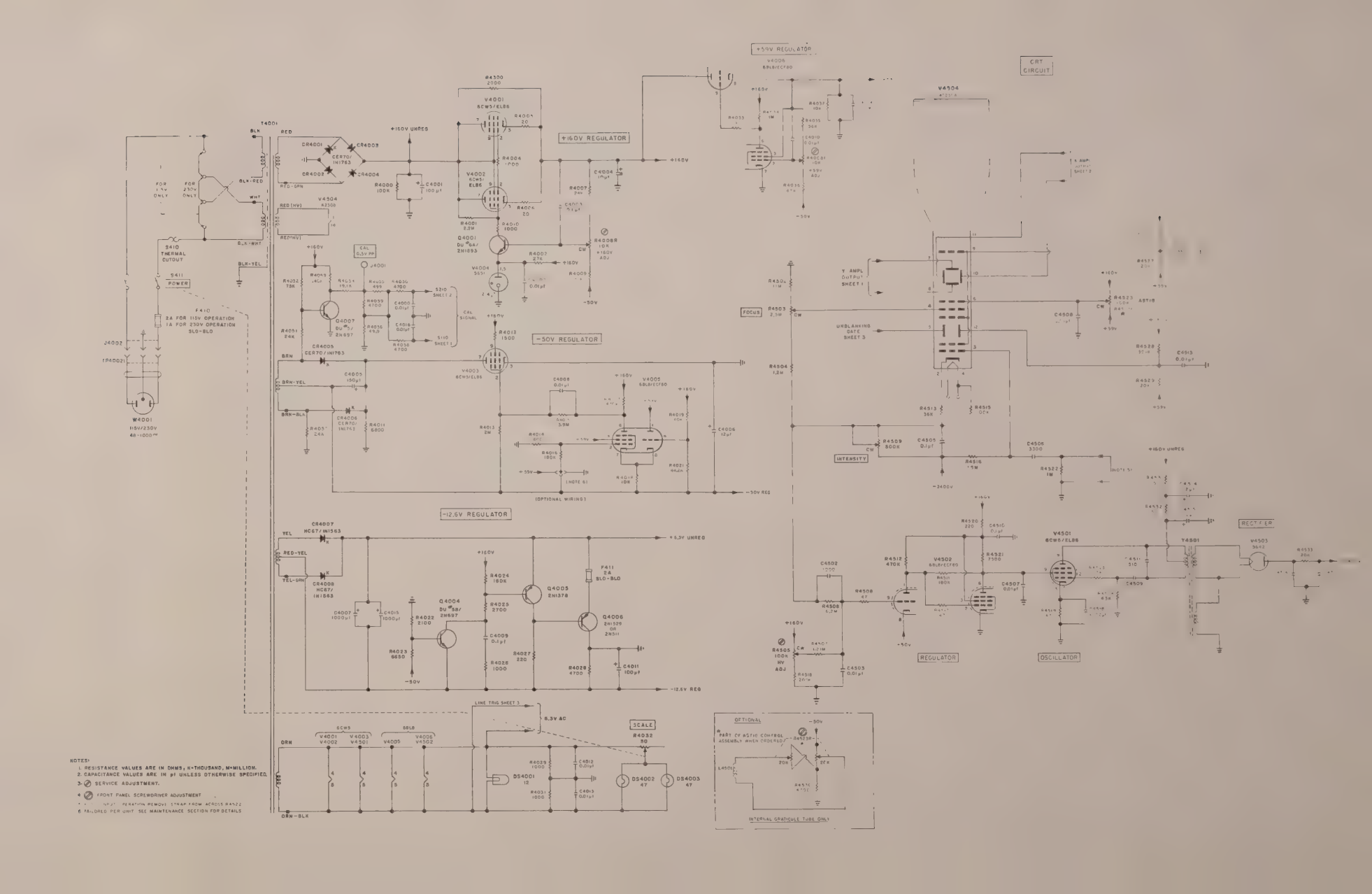
PATENT NOTICE

Manufactured under one or more U. S. Patents owned or controlled by Allen B. Du Mont Laboratories, Divisions of Fairchild Camera and Instrument Corporation, 750 Bloomfield Avenue. Clifton, New Jersey, U.S.A. Patent Numbers supplied upon request.




J2001
J2002
C2001
C2002
C2003
C2004
C2005
C2006
C2007
C2008
C2009
C2010
C2011
C2012
C2013
C2014
C2015
C2016
C2017
C2018
C2019
C2020
C2021
C2022
C2023
C2024
C2025
C2026
C2027
C2028
C2029
C2030
C2031
C2032
C2033
C2034
C2035
C2036
C2037
C2038
C2039
C2040
C2041
C2042
C2043
C2044
C2045
C2046
C2047
C2048
C2049
C2050
C2051
C2052
C2053
C2054
C2055
C2056
C2057
C2058
C2059
C2060
C2061
C2062
C2063
C2064
C2065
C2066
C2067
C2068
C2069
C2070
C2071
C2072
C2073
C2074
C2075
C2076
C2077
C2078
C2079
C2080
C2081
C2082
C2083
C2084
C2085
C2086
C2087
C2088
C2089
C2090
C2091
C2092
C2093
C2094
C2095
C2096
C2097
C2098
C2099
C2100
C2101
C2102
C2103
C2104
C2105
C2106
C2107
C2108
C2109
C2110
R2001
R2002
R2003
R2004
R2005
R2006
R2007
R2008
R2009
R2010
R2011
R2012
R2013
R2014
R2015
R2016
R2017
R2018
R2019
R2020
R2021
R2022
R2023
R2024
R2025
R2026
R2027
R2028
R2029
R2030
R2031
R2032
R2033
R2034
R2035
R2036
R2037
R2038
R2039
R2040
R2041
R2042
R2043
R2044
R2045
R2046
R2047
R2048
R2049
R2050
R2051
R2052
R2053
R2054
R2055
R2056
R2057
R2058
R2059
R2060
R2061
R2062
R2063
R2064
R2065
R2066
R2067
R2068
R2069
R2070
R2071
R2072
R2073
R2074
R2075
R2076
R2077
R2078
R2079
R2080
R2081
R2082
R2083
R2084
R2085
R2086
R2087
R2088
R2089
R2090
R2091
R2092
R2093
R2094
R2095
R2096
R2097
R2098
R2099
R2100
R2101
R2102
R2103
R2104
R2105
R2106
R2107
R2108
R2109
R2110
R2111
R2112
R2113
R2114
R2115
R2116
R2117
R2118
V201
V202
V203
V204
V205
V206
V207
V208
V209
V210
Q2001
Q2002
S201
S202
S203
S204
S205
S206
S207
S208
S209
S210
S211
S212
S213
S214
S215
S216
S217
S218
S219
S220
S221
S222
S223
S224
S225
S226
S227
S228
S229
S230
S231
S232
S233
S234
S235
S236
S237
S238
S239
S240


TRIG SOURCE
TRIG COUPL'NG
TRG SLOPE
TRIGGER AMPL. FIER
SCHMITT TRIGGER GENERATOR
SWEEP GATE
TIME/CM
DISCONNECT
GRID OF MILLER INTEGRATOR
TIMING RESISTORS
TIMING CAPACITORS
LOCKOUT CAPACITORS
MILLER INTEGRATOR
POSITION
HEATERS
ROTARY SWITCHES ARE SHOWN FULLY CCW

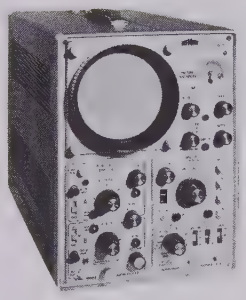

+150V REGULATOR
-50V REGULATOR
-12.6V REGULATOR
CRT CIRCUIT
REGULATOR
OSCILLATOR
RECTIFIER
INTENSITY
FOCUS
+150V UNREG
+6.3V UNREG
-12.6V REG
-50V REG
+150V
-50V
6.3V AC
SCALE
OPTIONAL
INTERNAL GRATICULE TUBE ONLY
NOTES:
1. RESISTANCE VALUES ARE IN OHMS; K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN µf UNLESS OTHERWISE SPECIFIED.
3. SERVICE ADJUSTMENT.
4. FRONT PANEL SCREWDRIVER ADJUSTMENT
6. TAILORED PER UNIT. SEE MAINTENANCE SECTION FOR DETAILS

INSTRUMENTS . . .
OSCILLOSCOPE CAMERAS
and ACCESSORIES

DU MONT

OSCILLOSCOPES

UNIVERSAL FAMILY OF SOLID-STATE OSCILLOSCOPES
5 mv/cm at 25 Mc
765 SERIES



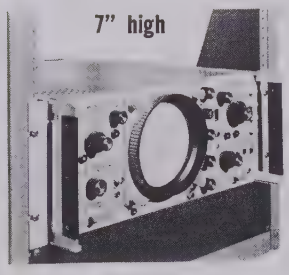
TYPE 766 PORTABLE-BENCH UNIT

The smallest, lightest (27 lbs.) high-frequency bench or portable oscilloscope available. With extended capabilities — such as the reliability of silicon-transistor circuits, plug-in circuits interchangeable between X and Y channels (or in any of the 765 Series) . . . all in a smaller main frame — the 766 brings superior capabilities to the field formerly known only to the laboratory engineer. Weight main frame — 27 lbs. **Price: (766 with dual-trace and time base plug-ins, signal delay and probes) $1500.00**

BRIEF SPECIFICATIONS *(common to all 765 Series)*

Frequency Range: dc — 25 mc, useful to above 40 Mc
Sensitivity: 5 mv/cm at 25 Mc
Mechanical: (765) 24″ x 17¾″ x 8⅛″; 27 lbs.
(766) 20⅝″ x 9¾″ x 13¾″; 29¾ lbs.
(767) 22¾″ x 20″ x 16¾″; 27 lbs.
20″ dimension is depth behind panel.

7" high



TYPE 767 PORTABLE BENCH/RACK UNIT

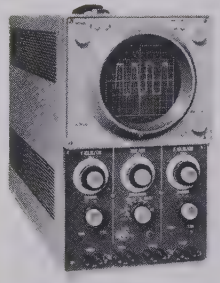
The same high-frequency features combined into an extruded aluminum frame, with rugged uni-body plastic handles for arduous duty — for portable, bench or rack applications. Reversible side flanges enable flush mounting into standard 19″ relay rack, or mounted to extend 1⅜ inches in front of panel if rack depth is lacking.

TYPE 765 PORTASCOPE* FOR THE ENGINEER ON THE GO

A "suitcase" version of the 766 — with identical, highly desirable capabilities — packaged in a sleek fiber-glass carrying/storage case for extreme portability. The 765 operates in a vertical or horizontal position for ease in viewing; the fold under handle raises the front panel off the bench to further enhance the viewing. The lid of the carrying case provides storage for probes, leads, etc.

* Trademark

GENERAL PURPOSE



TYPE 401-B

Featuring identical X and Y amplifiers, precisely calibrated displays on both axes with "electronic shutter" beam brightening, wide range of sweeps including single sweep with rearming, selection of single, auto or driven sweep. Operated at 5 kv for high light output. Bench or rack versions.

Sensitivity: 10 mv/cm. Differential or single ended input.

Frequency Range: dc to 500 kc, usable beyond 1 mc.

Rise Time: 0.7 μsec.

Sweep Range: 1 μsec/cm to 2 sec. full scale (0.2 μsec/cm with 5X expander), vernier control to 10 sec full scale. 17 calibrated sweep rates. **Price: $545.00**

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

DU MONT

ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

Instrument Sales Department

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Fairchild International Division
515 Madison Avenue
New York 22, N. Y.

HIGH FREQUENCY

TYPE 425

The most modern and versatile oscilloscope commercially available — it will always defy obsolescence. The 425 features direct digital ReadOut of measurements from three digit thumbswitches on both axis — no dials to multiply or scales to interpolate. This precise ReadOut system may be used as an analog to digital converter with 0.5% accuracy so as to minimize costly errors and permit precise digital measurements of time and amplitude from dc to over 1000 mc. A large selection of functional X and Y plug-ins are available — two being used simultaneously — assuring versatility. A two-dot method of waveform measurement eliminates guess work, permitting accurately repeatable measurements even by untrained personnel.

Frequency Range: dc to 35 mc, useful to 60 mc — to beyond 1000 mc with Type 4210 sampling plug-in.

ReadOut: 2-dot comparator system. Digital and analog outputs. Precision and repeatability better than ½%.

Sweep Speeds: 0.05 μsec/cm to 2 sec/cm in 24 calibrated steps (1 min. full scale to 10 nsec/cm with expander). Vernier included.

Price: $2975.00 (main frame)

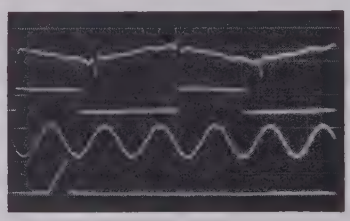
AVAILABLE PLUG-INS

		Price:
Type 4201	Y-Preamplifier; single channel, sensitivity 50 mv/cm to 20 v/cm, dc to 35 mc.	$ 195.00
Type 4202	Dual-Trace Y-Preamplifier; dc to 33 mc on both traces; 50 mv/cm.	295.00
Type 4203	Delaying Sweep; continuous variable sweep delay; 25 nsec to 10 sec. Precision nominally better than ½%. Jitter less than 1 part in 30,000.	495.00
Type 4204	X-Input; sensitivity 2 v/cm to 10 v/cm; dc to 21 mc.	125.00
Type 4205	Y-Preamplifier; sensitivity 5 mv/cm to 2 v/cm: dc to 21 mc.	275.00
Type 4206	Y-Preamplifier and Differential Comparator; 500 μv/cm to 20 mv/cm; 10 mc differential input. Common mode rejection nominally 60,000 to 1. 600 volts maximum offset.	*
Type 4207	Y-Test Unit; provides signals for Type 425. Vertical amplifier alignment and recalibration.	140.00
Type 4208	Power Access; supplies 5 regulated outputs from +420 to —150 volts for use with systems and in the laboratory.	75.00
Type 4209	Micro-Delay; provides trigger delay from 0 to 100 nsec; 0.1 nsec resolution for precise incremental rise time and delay measurements.	295.00
Type 4210 A/B	Sampling Scope; Dual-trace bandwidth greater than 1000 mc; rise time 0.35 nsec; sensitivity 5 mv/cm, 50 ohm input; sweep speeds 0.2 nsec/cm to 10 nsec/cm in 1, 2 and 5 steps; delay 0 to 100 nsec.	1495.00
Type 4211	Sweep Expander and X-Preamplifier; for X-Y displays with stable, wideband (2 mc) characteristics. Sweep expansion to x100.	235.00
Type 4212	Four Trace; provides single, dual or four traces over DC · 30 mc range; sensitivity 50 mv to 2 v/cm. Permits most versatile display of unrelated signals available. Permits differential dual-trace and dual-trace with ReadOut.	*
Type 4213	Raster Display; a 33 mc, 50 mv/cm amplifier with quartz crystal-controlled triangular waveform generator for vertical channel. Risetime 11 μsec, extremely high timing resolution. Oone to 10 μsec/line, 75 lines. Used for single shot recording of complex pulse trains found in explosives research and nuclear physics.	*
Type 4214	Two Element: Used for digitizing transistor life test data, magnetic core data and zener diode information. 2 ma to 200 volts reverse voltage.	*

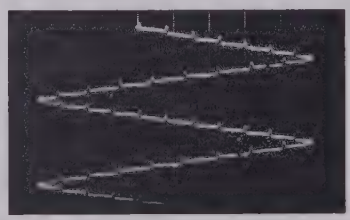
* Price on request

Typical Oscillograms

Display using Type 4202 Dual-Trace Y-Preamplifier Plug-in, with Type 4203 Delaying Sweep Plug-in, to create a strobe on the trace segment (upper trace) while delaying and expanding the same segment for detailed analysis simultaneously (lower trace).



Four waveforms as displayed using the Type 4212 Four-Trace Plug-in.



0.1 μsec pulses every 9 μsec as displayed using the Type 4213 Raster Display Plug-in. Each line represents 10 μsec., markers appear every 1 μsec.

OSCILLOSCOPES AND INSTRUMENTS

TYPE 440

MEDIUM FREQUENCY

For precision investigations in ranges approaching high-frequency. Features relatively low-cost, 17 sweep speeds, accurate calibration, simplified auto triggering, 5 kv operation for brighter displays, and single sweep triggering.

Frequency Range: Vert: dc to 5 mc, usable beyond 10 mc. Horiz: dc to 500 kc.

Rise Time: Vert: 70 nsec. Horiz: 700 nsec.

Sensitivity: Vert: 50 mv/cm to 150 v/cm (500 volts full scale). Horiz: 10 mv/cm to 150 v/cm. Differential input on all attenuator positions.

Sweep Range: 1 μsec/cm to 0.2 sec full scale. 10 sec full scale to 0.2 μsec/cm with expander.

Price: $660.00

TYPE 403-B

HIGHLY SENSITIVE

Resolves 15 μv signals. Sensitive enough to display non-preamplified outputs of most transducers. All critical amplifier circuits transistorized for stability. Complete precision calibration at all levels. Bench or rack version. Differential input provided on both amplifiers.

Frequency Range: dc to 500 kc, usable beyond 1 mc.

Sensitivity: Ver: 50 μv/cm dc, 100 μv/cm ac. Horiz: 10 mv/cm.

Sweep Range: 1 μsec/cm to 5 sec/cm (4 min. full scale to 0.12. μsec/cm with expander). 21 calibrated sweeps.

Price: $760.00

TYPE 430

STORAGE

Smaller, higher spot resolution, and CRT replacements costing less than half that of other storage scopes (minimum 10,000 erases). Identical amplifiers. Rate brightening and screen protection circuitry included. Ideal for biological studies, shock and vibration testing, servo work, cam analysis, etc.

Price: $1395.00

Storage Time: Seconds to days.

Single Shot Writing Rate: 25,000 cm/sec. 10 kv on CRT with P10 phosphor.

Erase Time: 15 sec; new storage cycle every 45 sec.

Frequency Range: dc to 10 kc. } on both X &
Sensitivity: 10 mv/cm to 10 v/cm. } Y amplifiers

Sweep Range: 50 μsec/cm to 20 sec/full scale in 15 steps (10 μsec/cm to 100 sec full scale with expander). Calibrated accuracy nominally 2%.

TYPE 304-A

GENERAL PURPOSE OSCILLOSCOPE

More 304-A's have been purchased than any other oscilloscope ever made — truly an industry standard. An all-around, reliable work-horse. Bench or rack versions.

Frequency Range: dc to 100 kc.

Sensitivity: 100 mv dc full scale.

Sweep Range: 2 cps to 30 kc.

Price: $465.00

TYPE 404-B

PULSE GENERATOR

Standard Pulse Generator for the laboratory. Hard-tube circuitry eliminates jitter, overshoot and ringing. Push-button atenuation in 0.5 db increments to 59.5 db. Bench or rack versions. Meets or exceeds environmental tests of appropriate military specifications.

Price: $760.00

Output: 55 volts into 50 ohms, 90 volts into 95 ohms.

Repitition Rate: Single pulse and 10 pps to 250K pps, continuously variable.

Pulse Rise Time: 13 nsec.

Trigger Delay: 2 μsec advance to 12,500 μsec, continuously variable.

Pulse Widths: 0.05 to 105 μsec, calibrated within 3%.

INSTRUMENT ACCESSORIES

Type	Description	Price:
4001	Sweep Rearming Kit for use with Types 401B, 403B, and 440	$ 6.50
4002	Accessory Kit; includes the Anti-parallax Scale, Test Probe, Hood, Type 4002A Test Fixture (620K-ohm resistor), and Terminal Adapters Type 2592-B and BNC Type UG1090/U	65.00
4003	Maximum Sweep Expansion Calibration Kit; Modifies Types 401B, 403B, 430, and 440 for calibrated x5 sweep expansion	7.50
4004	Sync Ready Indicator Kit for use with Types 401B and 440	7.50
4005	Tilt Foot and Cord Reel Accessory Kit for 401B, 403B, 430 and 440	(on request)
4270	Scope Traveler, collapsible, for use with the Type 420 Series Oscilloscopes	85.00
4285	50-ohm, 2-watt termination for use with Type 420 Series Oscilloscope Plug-ins	16.50
4290	10:1 Attenuator Probe terminated in BNC type connector; 10 megohms, 10 pf input	30.00
2592-B	Shielded terminal adapter, unterminated; this is a binding post to BNC type adapter	10.00
0903 6940	Connector, BNC type to binding post adapter; UG1090/U	2.35
276-C	Viewing Hood	10.00
4295	Maintenance Accessory Kit for 425 Test Fixtures	70.00
4296	Operational Accessory Kit for 425, Probe, Hood, Termination, Angle Adapters, Scale	60.00

TYPE 4270 SCOPE DOLLY

TYPE 4290 PROBE

OSCILLOSCOPE CAMERAS

SINGLE FRAME RECORDING STANDARD FILM

Object-to-image reduction — 2-¼:1
Direct binocular viewing and reverse recording.

Type 299

Camera back: Graflex roll film with sliding adapter.

Film and Size: 120 roll film (2¼ x 3¼).

Lens and Shutter: Wollensak f/2.8, 75 mm (3") with Alphax #2 1/25 to 1/100, time and bulb.

or Wollensak f/1.9, 75 mm (3") with Alphax #3 1 second to 1/100, time and bulb.

Price: (with f/1.9 lens) $395.00
(with f/2.8 lens) 350.00

Accessories: Polaroid back with sliding adapter
Viewing and focusing hood
Film pack holder
Sheet film holder
Storage and carrying case
Bezel Adapter

SINGLE FRAME RECORDING POLAROID FILM

Object-to-image reduction — 2¼:1
Direct binocular viewing and reverse recording.

Type 302

Camera back: Polaroid with sliding back.

Film and Size: Types 44, 46L and 47. 8 exposure rolls (3¼ x 4¼).

Lens and Shutter: Wollensak f/2.8, 75 mm (3") with Alphax #2 1/25 to 1/100, time and bulb.

or Wollensak f/1.9, 75 mm (3") with Alphax #3 1 second to 1/100, time and bulb.

Price: (with f/1.9 lens) $435.00
(with f/2.8 lens) 365.00

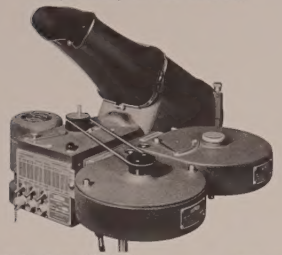
Accessories: Mount for Graflex accessories
Viewing and focusing hood
Graflex roll film back (2¼ x 3¼)
Film pack holder
Sheet film holder
Storage and carrying case
Bezel Adapter

WHERE QUALITY IS A CREED . . . AS WELL AS A SPECIFICATION

OSCILLOSCOPE CAMERAS

CONTINUOUS MOTION RECORDING

Object-to-image reduction — 4.9:1
Oblique viewing and direct recording.



Type 321A

Price: (with f/1.5 lens) $1395.00
(with f/2.8 lens) 1295.00

Film: 35 mm film or paper, perforated or unperforated in 400-foot daylight loading magazine.

Lens: Wollensak f/1.5, 51 mm (2″) or Wollensak f/2.8, 51 mm (2″).

Shutter: Capping type in camera.

Speeds: 18 speeds from 8 inches/minute to 10,800 inches/minute.

Support: Adjustable support stand.

Accessory: Storage and carrying case

FULL-IMAGE SIZE RECORDING

Object-to-image ratio — 1:1
Oblique monocular viewing and direct recording.

Type 353

Price: (with f/1.9 lens) $385.00
(with f/2.8 lens) 340.00

Camera back: Polaroid with sliding back.

Film and Size: Types 44, 46L, and 47. 8 exposure rolls (3¼ x 4¼).

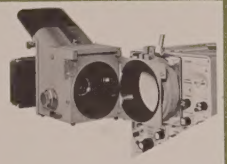
Lens and Shutter: Wollensak f/2.8, 75 mm (3″) with Alphax #2 1/25 to 1/100, time and bulb.

or Wollensak f/1.9, 75 mm (3″) with Alphax #3 1 second to 1/100, time and bulb.

Accessories: Mount for Graflex accessories
Viewing and focusing hood
Graflex roll film back (2¼ x 3¼)
Film pack holder
Sheet film holder
Storage and carrying case
Bezel Adapter

NOTE: All accessories except carrying cases are interchangeable between the Types 299, 302, and 353.

MULTIPLE IMAGE-SIZE, HIGHLY VERSATILE RECORDING with swing away viewing



Type 450-A

Features

- Quick and secure mounting with ratchet-actuated clamp.
- Precision rack and pinion focusing.
- Precision size adjustment.
- All shutters have synchro-connectors.
- Sliding backs have positive detented positions for multiple full scale recordings.
- Quick change bayonet lens mount.
- Quick change backs.
- All metal construction with lightweight precision die-cast housing.
- Dark slide for changing backs without fogging film.
- Hinged at bezel clamp for swing away, direct viewing of trace.

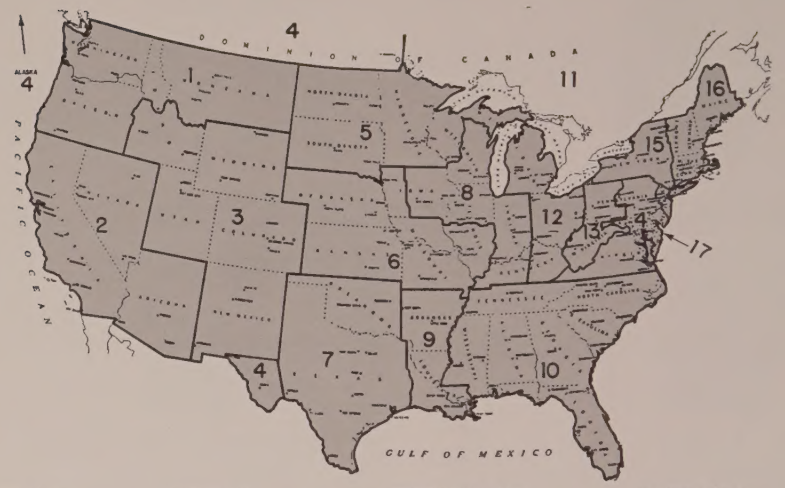
The most versatile camera available. Interchangeable lenses for object-to-image ratios from 1:1 down to 1:0.222, and interchangeable backs for records from 4 x 5 to 35 mm. Oblique binocular viewing and direct non-reversing recording.

Camera backs: Graflok 4 x 5. Polaroid 3¼ x 4¼. Graflex 2¼ x 3¼. Robot 35 mm.
Film types: All types of Polaroid or standard film.
Lens and Shutter: f/1.9, 75 mm (3″) and/or f/1.9, 63 mm (2½″) with Alphax #3, 1 second to 1/100, time and bulb.
f/1.5, 51 mm (2″) — this lens is used with the 35 mm camera only. The Robot focal plane shutter provides speeds from 1/25 to 1/500 and bulb.
Price: 450-A with 1:1, f/1.9 lens and Polaroid back (as pictured) **$560.**, other prices dependent on accessories selected.

ACCESORIES:

Type	Description	Type	Description
4517	Polaroid 4 x 5 film adapter	4534	Remote shutter solenoid for Robot, 110 VAC
4521	Remote shutter operation, 2.5 VDC	4535	Remote shutter solenoid for Robot, 24 VDC
4522	Remote shutter operation, 28 VDC	4536	Electric booster motor for Robot, 24 VDC
4523	Remote shutter operation, 115 VAC	4537	Transformer - rectifier 110 VAC input with two 24 VDC outputs
4525	Mirror Assembly	4538	2400-exposure film magazine for Robot
4526	Data card and light source assembly	4539	Remote control reverse shutter solenoid for Robot, 24 VDC
4527	Nixie Readout Assembly	4542	Storage and carrying case
4531	400-exposure film magazine for Robot		
4532	Spring booster motor for Robot		

DUMONT INSTRUMENT SELLING AGENTS



ALBUQUERQUE, N. Mex.
Franklin Y. Gates
122 Harvard Drive, S.E.
242-3613

ATLANTA, Ga.
Murphy and Cota
2110 Peachtree Road, N.W.
TRinity 6-3020

BALTIMORE, Md.
Thom. H. Closs & Co.
21 W. Pennsylvania Ave.
Towson, Md.
VA 5-4445

BINGHAMTON, N. Y.
SBM Associates
Nowlan Rd., R.D. #3
RAymond 2-2648

BOSTON, Mass.
Allen B. Du Mont Laboratories
Divisions of Fairchild Camera and Instrument Corp.
49 Walnut Street
Wellesley Hills, 81
CEdar 5-7550

CHARLOTTE, No. Carolina
Murphy & Cota
221 Latta Arcade
EDison 2-7356

CHICAGO, Illinois
Hugh Marsland & Company
6699 Lincoln Avenue
ORchard 6-1100

CLEVELAND, Ohio
Electro Sales Associates
335 East 200 St.
REdwood 2-7444

DALLAS, Texas
John A. Green Co.
7118 Envoy Court
MElrose 1-7460

DAYTON, Ohio
Electro Sales Associates
5890 Mapleview Drive
CHapel 4-5561

DETROIT, Michigan
Electro Sales Associates
15324 Mack Ave.
TUxedo 6-2280

ENGLEWOOD, Colo.
F. Y. Gates Co.
3395 So. Bannock
SUnset 1-8566

HOUSTON, Texas
John A. Green Co.
Room 110, 3400 Montrose
JAckson 6-2959

HUNTSVILLE, Alabama
Murphy and Cota
112 Gallatin St., S.W.
536-9121 or 539-8476

INDIANAPOLIS, Indiana
Hugh Marsland & Company
6730 E. 19th Street
FLeetwood 6-4249

KANSAS CITY, Mo.
Engineering Services Co.
7546 Tronst Ave.
EMerson 1-9600

LOS ANGELES, California
J. T. Hill Company
420 So. Pine St., San Gabriel
CUmberland 3-6555
ATlantic 7-9633

MINNEAPOLIS, Minn.
Pinkney and Hine Co.
1925 Nicollet Avenue
FEderal 8-0523-0524

ORLANDO, Fla.
Murphy & Cota
2319 E. South St.
GArden 4-2167 or 5633

PHILADELPHIA, Penna.
Allen B. Du Mont Laboratories
Divisions of Fairchild Camera and Instrument Corp.
100 Old York Road
Jenkintown, Penna.
TUrner 7-6170

PITTSBURGH, Pa.
H. E. Ransford Co.
5400 Clairton Blvd.
TUxedo 4-3425

ROCHESTER, New York
SBM Associates
177 Winton Road North
OLympic 4-8440

ST. LOUIS, Mo.
Engineering Services Co.
6717 Vernon Ave.
PArkview 6-2233

SAN DIEGO, Calif.
J. T. Hill Co.
ZEnith 2-0719

SAN FRANCISCO, Calif.
J. T. Hill Company
1682 Laurel St.
San Carlos, Calif.
LYtell 3-7693

SALT LAKE CITY, Utah
Franklin Y. Gates
200 South Main
Room 822
ELgin 9-1101

SEATTLE, Wash.
Rush S. Drake Assoc.
1817 Norman St.
EAst 3-8545

SYRACUSE, N. Y.
SBM Associates
1943 W. Fayette St.
HOward 8-5041

TORONTO, ONT., Canada
Megatronix, Ltd.
1800 Avenue Rd.
783-3329

TULSA, Oklahoma
John A. Green Co.
P.O. Box 911
RIverside 2-4657

UTICA, N. Y.
SBM Associates
232 Roosevelt Dr.
REdwood 2-4410

WASHINGTON, D. C.
Allen B. Du Mont Laboratories
Divisions of Fairchild Camera and Instrument Corp.
1625 Eye St., N.W.
MEtropolitan 8-1232

WICHITA, Kan.
Engineering Services Co.
247 South Pinecrest
MUrray 3-3751

WINSTON-SALEM, N. C.
Murphy & Cota
1106 Burke St.
PArk 4-0750

FACTORY SALES OFFICE
Allen B. Du Mont Laboratories
750 Bloomfield Avenue
Divisions of Fairchild Camera and Instrument Corp.
Clifton, N. J.
PRescott 3-2000

DU MONT

ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

Instrument Sales Department

Specifications subject to change without notice. See your Du Mont Field Engineering Representative for demonstrations and information on newer instruments to be announced.

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Fairchild International Division
515 Madison Avenue
New York 22, N. Y.

Printed in U.S.

www.manualsplus.com
1012833